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WATER SUPPLY WELLS - REQUIREMENTS AND BEST MANAGEMENT PRACTICES

PIBs # 7333e

Protecting our environment.

Ontario

Note: The numbers and details presented in this manual are current as of the date of publication. Any new regulation or legislation that has been written or revised following this date takes precedence over what is stated here

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Master Table of Contents

1. About This Manual

Chapter Table of Contents

Purpose

The intention of this manual is two-fold. First, it provides quick access to a simplified, clear and concise discussion of Regulation 903 as amended under the *Ontario Water Resources Act* R.R.O. 1990 (The **Wells Regulation**[1]). Second, it provides best management practices and recommended techniques that help a person constructing a well to go beyond the minimum standards set by the **Wells Regulation** and better protect and minimize adverse impacts to our environment. In this manual, best management practices are recommended actions or steps that exceed the minimum regulatory requirements to better protect the groundwater and the natural environment. If there are any discrepancies between this guidance and the **Wells Regulation,** the **Wells Regulation** takes precedence.

This manual covers requirements and best management practices for water supply wells. Examples of water supply wells include public, domestic, livestock, irrigation, industrial, municipal, and earth energy system (groundwater source) wells.

The best management practices presented in this manual provide a practice or combination of practices based on research, field-experience, and expert review, which are both effective and practical. At the time of release of this document, a separate manual is being prepared for test holes and dewatering wells titled *Test Holes and Dewatering Wells – Requirements and Best Management Practices*.

The terms “test hole” and “dewatering well” do not include any well that is used or intended for use in the future as a source of water for agriculture or human consumption. These types of wells must always comply with the **Wells Regulation** requirements covered in this manual.

Note: ***This manual is not intended to replace the Wells Regulation***, but to enhance the understanding and application of the **Wells Regulation**. The **Wells Regulation** must still be used and referenced as the legal and binding regulatory requirement. If there are any conflicts between this manual and the **Wells Regulation** or the *Ontario Water Resources Act*, the *Ontario Water Resources Act* and the **Wells Regulation** take precedence over this manual.

Note: This manual supercedes a number of previous Ministry publications including any and all fact sheets and technical bulletins regarding water wells in Ontario, published prior to the date of this publication, and the following:

- Water Wells and Groundwater Supplies in Ontario
- Tagging Ontario’s Wells

[1] For the purposes of this Best Management Practices manual, Regulation 903 will be referred to as the **Wells Regulation.**

How to Use This Manual

Each chapter in this manual is based on a specific topic of the well construction process. The Master Table of Contents found prior to Chapter 1 indicates the chapter titles.

Use this manual on the job and/or at the office to better understand, confirm and follow the requirements of the **Wells Regulation**, and go beyond the minimum requirements as recommended.

Note: ***Each chapter is intended to be read in conjunction with the entire manual*** and the chapters are not intended to be stand alone documents. Essential information may be missed if an individual chapter is taken out of the context of the manual.

Note: The graphics in this document

- are for illustrative purposes only,
- do not show all regulatory requirements, and
- are not to scale.

Note: The numbers and details presented in this manual are current as of the date of this publication. Any new regulation or legislation that has been written or revised following this date takes precedence over what is stated here.

ELEMENTS INCLUDED

Each chapter in this manual includes the following:

- **Table of Contents** – Identifies sections, sub-sections, figures, and tables found within the chapters.
- **Chapter Description** – Describes the purpose and gives an overall summary of the content covered within the chapter
- **Regulatory Requirements** – Summarizes the minimum requirements relevant within the chapter
    - Relevant Sections – The **Wells Regulation** – Lists the sections of the regulation that are relevant and referenced within the chapter
    - The Requirements – Plainly Stated – Provides a "basic terms" summary of the requirements laid out in the **Wells Regulation**
    - Relevant Sections – Additional Regulations or Legislation – Lists additional sections of regulations or legislation that are relevant and referenced within the chapter
    - Relevant Standards – Lists additional standards that are relevant and referenced within the chapter
- **Key Concepts** – Provides an overview of the processes, procedures and the Best Management Practices for completing the task(s) relevant to the chapter. The Key Concepts are expanded upon in the chapters.
- **Detailed Information** – Expands upon the Key Concepts and provides **best management practices**
- **Tools** – Where appropriate, provides tools that may be helpful on the job when completing the task(s) relevant to the chapter

The manual also includes the following:

- **Glossary**– Provides a list of relevant terms and their definitions
- **Ontario Legislation Section -** Contains the following:
    - ***Ontario Water Resources*** – Provides the current version of the sections of the *Ontario Water Resources Act* relevant to wells
    - **The Wells Regulation** – Provides the current version of the **Wells Regulation**
- **Resources** – Provides quick access to important contact information and additional related resources

Icon Descriptions

The following icons are used throughout the manual for easy reference.

The Wells Regulation – Indicates specific references to requirements

Best Management Practice – Indicates a best management practice

Definition – Indicates the definition of a term

Reminder – Indicates a reminder or note regarding important information

Role of Environmental Legislation and Regulations

In addition to everyone's responsibility to practice good environmental stewardship, legislation and regulations have been established for environmental protection.

Environmental impairment can exist in many forms including liquid waste spills or releases into lakes; improper application of pesticides sprayed on food crops; excessive discharge of exhaust material into the atmosphere; and entry of surface water or other foreign material into a well or aquifer. Whenever an activity involves impacts or potential impacts to the environment, a wide range of legislation and regulations usually apply at all levels of government. Legislation and regulations provide minimum requirements intended to protect human health, safety and the environment.

THE *ONTARIO WATER RESOURCES ACT:* AN OVERVIEW

Reference is made throughout this manual to the *Ontario Water Resource Act*.

Well construction in Ontario is governed by the *Ontario Water Resources Act* and the **Wells Regulation**. The Ministry of the Environment's (the Ministry or MOE) legislative authority to regulate water comes primarily from two acts, the *Ontario Water Resources Act* and the *Environmental Protection Act* (EPA).

The purpose of the *Ontario Water Resources Act* is to provide for the conservation, protection and management of Ontario's waters and for their efficient and sustainable use, in order to promote Ontario's long-term environmental, social and economic well-being. The *Ontario Water Resources Act*, which gives the Ministry extensive powers to regulate water supply, sewage disposal and to control sources of water pollution, expressly states in subsection 29(1) that for the purpose of the Act, the Minister has the supervision of all surface waters and groundwaters in Ontario.

The EPA prohibits the discharge of contaminants to the natural environment, including water except where specifically permitted by a certificate of approval. The goals, policies, and guidelines set out in this document assist persons making decisions under or related to the EPA and *Ontario Water Resources Act*. They give, for example, directions that assist in defining site-specific effluent limits, which then may be incorporated into certificates of approval or control orders. These control documents are issued under the authority of the legislation, and thus become legally binding and constitute the basis for compliance and enforcement actions. The policies and guidelines that are not incorporated into regulation or legislation by reference, do not have any formal legal status but, by their successful use over the years, are now seen as standard practices for water resources management.

There are other statutes that the Ministry uses to protect water resources and users, such as the *Safe Drinking Water Act, 2002* and the *Clean Water Act, 2006*. The *Clean Water Act* is not discussed in detail in this manual but the relevant sections of the *Safe Drinking Water Act* dealing with potable water are discussed in Chapter 14: *Abandonment: When to Plug & Seal Wells*.

There are many other important aspects of water management that do not fall under the jurisdiction of the Ministry, but are the responsibility of other provincial ministries and federal government departments, most notably the Ontario Ministries of Natural Resources, Health and Long Term Care, Agriculture Food and Rural Affairs, Conservation Authorities and the Federal Departments of Fisheries and Oceans and Environment Canada.

The *Ontario Water Resources Act* also sets out the consequences for non-compliance with the *Ontario Water Resources Act* and the **Wells Regulation**.

THE WELLS REGULATION: AN OVERVIEW

Ontario The **Wells Regulation** helps to ensure that groundwater quality, well water quality, and the environment are protected by the following means:

- The elements contained in the **Wells Regulation** are aimed at protection – of the resource, the well owner, the industry, and the well water
- The **Wells Regulation** identifies what must be done by the person constructing the well to ensure that well construction activities do the following:
    - Protect aquifers and water resources,
    - Protect aquitards,
    - Protect water quality and quantity, and
    - Protect the health and safety of the well owner and users
- The **Wells Regulation** covers the minimum standards for obtaining licences and carrying out the elements of the work that can affect the well, the environment, human health and the owner

Ontario The **Wells Regulation** covers the following:

- Qualifications and requirements for obtaining and maintaining both well contractor and well technician licences
- Required steps before work on the well begins
- Required steps during the well construction process
- Approved materials and steps relating to casing, well screens, sealant, disinfection and pumping test
- Required steps for sealing the annular space
- Required steps to take after the well construction is complete such as notifications (e.g. tags and records)
- Requirements for when to abandon a well and how to seal a well
- Well owner's responsibilities
- Exemptions for certain types of excavations, activities, persons and shallow works

Protecting the Environment

A condition of both the well technician licence and the well contractor licence is that licence holders must comply with all of the provisions of the legislation and **Wells Regulation** at all relevant times. Also, any other person working on a well must also comply with the legislation and the **Wells Regulation**. It is important to understand that carelessness or cost cutting during well construction and maintenance, costs everyone.

The nature of an aquifer makes it difficult, if not impossible to repair. Cleanup, if it is even possible, is very costly and positive results can take years to achieve. Remember that a single well can contaminate an entire aquifer, and affect the lives of many people.

The **Wells Regulation** benefits all of the people of Ontario.

It is a privilege and a responsibility to be guardians or stewards of water, which is the basis of the livelihoods of licensed well technicians and other professionals. Each of us must do our part to protect groundwater from contamination, and all harmful practices.

The continued protection of the groundwater resource will ensure that people will continue to want to use groundwater as their water source. Nobody wants or can use a new well constructed in a contaminated aquifer. Old wells may have to be abandoned.

Key Message

The **Wells Regulation** sets out the minimum requirements for well construction. It is a good idea to exceed these minimum requirements where the professional judgment of the person constructing the well indicates that actions beyond the minimum regulatory requirements are needed. During construction, situations may be identified where it may be beneficial to exceed the requirements to better protect the natural environment.

2. Definitions & Clarifications

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Chapter Tables

Chapter Description

This chapter defines, clarifies and describes the terms used in the **Wells Regulation** and the *Ontario Water Resources Act* that are used in this manual. Other key terms used in this manual, which are not used in the **Wells Regulation** and the *Ontario Water Resources Act,* are described in the glossary.

Relevant Sections – The Wells Regulation

Ontario ***Definitions – Section 1***

Relevant Sections – Additional Regulations or Legislation

Ontario Water Resources Act, R.S.O. 1990, Chapter 0.40 – Sections 1, 35(1), 35(2)

Environmental Protection Act, S.O. 1999, Chapter 33

Safe Drinking Water Act, S.O. 2002, Chapter 32

Regulation 169/03 as amended (Ontario Drinking Water Quality Standards)

Building Code Act, S.O. 1992, Chapter 23

Regulation 350/06 as amended (Building Code)

Nutrient Management Act, S.O. 2002, Chapter 4

Labour Relations Act, S.O. 1995, Chapter 1

Agricultural Employees Protection Act, S.O. 2002, Chapter 16

KEY DEFINITIONS AND DESCRIPTIONS

Ontario

Table 2-1: Definitions found in the Wells Regulation Section 1, and the *Ontario Water Resources Act*

Term	Definition	Further clarification
Agency	The Ontario Clean Water Agency	Subsection 1(1) of *Ontario Water Resources Act*
Air Vent	An outlet at the upper end of the casing that allows for equalization of air pressure between the inside of the casing and the atmosphere and for the release of gases from the well	Subsection 1(1) of the **Wells Regulation**
Analyst	An analyst appointed under the *Environmental Protection Act*	Subsection 1(1) of *Ontario Water Resources Act*
Annular Space	An open space between a casing or well screen and the side of a well, and includes space between overlapping casings within the well	Subsection 1(1) of the **Wells Regulation** For the purposes of this manual the term "annulus" has the same meaning as annular space.
Aquifer	A water-bearing formation that is capable of transmitting water in sufficient quantities to serve as a source of water supply	Subsection 1(1) of the **Wells Regulation** See "Useful Aquifer" in Table 2-2
Assistant Well Technician	A person who works at the construction of wells as an employee or agent of the holder of a well contractor licence under the supervision of the holder of a well technician licence	Subsection 1(1) of the **Wells Regulation**
Bedrock	(a) The solid rock underlying unconsolidated material such as gravel, sand, silt and clay, or (b) solid rock that is exposed at the ground surface	Subsection 1(1) of the **Wells Regulation** This excludes glacial erratics or boulders as they are loose and unstratified and considered to be overburden. In Ontario, overburden is generally underlain by bedrock.

Term	Definition	Further clarification
Bentonite	A commercially produced sealing material used in well construction or abandonment that, (a) consists of more than 50 percent sodium montmorillonite by weight, (b) has the ability to swell in the presence of water, (c) does not provide nutrients for bacteria, and (d) does not impair the quality of water with which it comes in contact	Subsection 1(1) of the **Wells Regulation**
Casing	Pipe, tubing or other material installed in a well to support its sides, but does not include a well screen	Subsection 1(1) of the **Wells Regulation**
Chlorinated	Disinfected with free chlorine residual	Subsection 1(1) of the **Wells Regulation**
Construct	When used with respect to a well, means bore, dig, drill or otherwise make, extend or alter. Construct also includes installing equipment in or connected to a well.	Subsections 35(1) and 35(2) of the *Ontario Water Resources Act* An alteration includes the installation of a pump and associated pumping equipment. Well abandonment is not considered to be well construction (see the description for "Well Abandonment" in Table 2-2)
Crown	Her Majesty the Queen in right of Ontario	Subsection 1(1) of the *Ontario Water Resources Act*
Dewatering Well	A well that is not used or intended for use as a source of water for agriculture or human consumption and that is made (a) to lower or control the level of groundwater in the area of the well, or (b) to remove materials that may be in the groundwater	Subsection 1(1) of the **Wells Regulation** Removal of materials could include a pump and treat well system that is removing contaminated groundwater from an aquifer.
Director	A Director appointed under section 5	Subsection 1(1) of the *Ontario Water Resources Act* Subsection 5(1) of the *Ontario Water Resources Act* for the purposes of the **Wells Regulation**
Discharge	When used as a verb, includes add, deposit, emit or leak and, when used as a noun, includes addition, deposit, emission or leak	Subsection 1(1) of the *Ontario Water Resources Act*

Term	Definition	Further clarification
Flowing Well	A well that has a static water level above the ground surface	Subsection 1(1) of the **Wells Regulation**
Holder	When used in reference to a licence, permit or approval, means a person who is bound by the licence, permit or approval	Subsection 1(1) of the *Ontario Water Resources Act*
Inspection	Includes an audit, examination, survey, test and inquiry	Subsection 1(1) of the *Ontario Water Resources Act*
Justice	A provincial judge or a justice of the peace	Subsection 1(1) of the *Ontario Water Resources Act*
Land	Includes any estate, term, easement, right or interest in, to, over or affecting land	Subsection 1(1) of the *Ontario Water Resources Act*
Mineralized Water	Water containing in excess of 6,000 mg/L total dissolved solids or 500 mg/L chlorides or 500 mg/L sulphates	Subsection 1(1) of **Wells Regulation**
Minister	The Minister of the Environment	Subsection 1(1) of the *Ontario Water Resources Act*
Ministry, or MOE	The Ministry of the Environment	Subsection 1(1) of the *Ontario Water Resources Act*
Minor Alteration	With respect to a well, (a) routine repair or maintenance, (b) the installation of monitoring, sampling or testing equipment, other than equipment used to test the yield of the well or the aquifer, (c) the installation of a pump in a test hole, or (d) the installation of a well cap or watertight well cover	Subsection 1(1) of the **Wells Regulation** See the description for “Routine Repair” in Table 2-2.
Natural Environment	Has the same meaning as in the *Environmental Protection Act*	Subsection 1(1) of the *Ontario Water Resources Act* Subsection 1(1) of EPA: Natural environment means the air, land and water, or any combination or part thereof, of the Province of Ontario.
Overburden	Unconsolidated material overlying bedrock	Subsection 1(1) of the **Wells Regulation**

Term	Definition	Further clarification
Person Constructing a Well	A well technician or other individual who works at the construction of the well A well purchaser is not a person constructing a well.	Subsection 1(2) of the **Wells Regulation**
Province	The Province of Ontario	Subsection 1(1) of the *Ontario Water Resources Act*
Provincial Officer	A person who is designated under Section 5	Subsection 1(1) of the *Ontario Water Resources Act* Subsection 5(3) of the *Ontario Water Resources Act* for the purposes of the **Wells Regulation**
Pump	Includes associated pumping equipment	Subsection 1(1) of the **Wells Regulation** Equipment includes any equipment installed into or onto a well that is integral to the pumping of the well water Associated pumping equipment can include: • all the parts of a pump installed in a well • waterlines (sometimes called lateral pipes and drop pipes) and their associated parts in or attached to the well • pitless adapters and pitless units • sanitary well seals, and • electrical lines to operate a pump In some cases if a pump part is attached to the well cap or cover, the well cap or cover could also be associated pumping equipment.
Regulated Person	(a) A person who belongs to a class of persons prescribed by the regulations and who holds or is required to hold, (i) an approval, licence or permit under this Act, or (ii) a certificate of approval, provisional certificate of approval, certificate of property use, licence or permit under the *Environmental Protection Act*, or (b) a corporation that belongs to a class of corporations prescribed by the regulations	Subsection 1(1) of the *Ontario Water Resources Act*
Regulations	The regulations made under this act	Subsection 1(1) of the *Ontario Water Resources Act*

Term	Definition	Further clarification
Sealant	(a) a slurry consisting of clean water and at least 20 percent bentonite solids by weight, or (b) other material that is equivalent to a slurry described in clause (a) with respect to the ability to form a permanent watertight barrier	Subsection 1(1) of the **Wells Regulation** For the purposes of this manual the term "grout" has the same meaning as suitable sealant. See also, definitions of "Clean" and "Watertight" in Table 2-2. An approved material for sealant has to be a material that can provide as much of a permanent watertight barrier as the approved bentonite mixture in the environment the sealant will be used. In problematic environments where bentonite is not sufficiently watertight, the definition of sealant could allow for other materials to be sands or gravels in a well's annular space. However, the annular space must be sealed with a material that prevents any movement of water, natural gas, contaminants or other material between the subsurface formations, aquifers and/or ground surface and performs like (a) in a non-problematic environment. In this case, other material could include but is not limited to the following: • concrete or cement slurry, • a layer or layers of concrete or cement with layers of clays, silts, sands, gravels, or other materials, • a layer or layers of clays, silts, sands, gravels and drill cuttings, and/or • a mechanical device such as a neoprene packer.
Static Water Level	The level attained by water at equilibrium in a well when no water is being taken from the well	Subsection 1(1) of the **Wells Regulation** In equilibrium with the atmosphere Also requires that no water is being added to the well
Subsurface Formation	Includes an aquifer	Subsection 1(1) of the **Wells Regulation**
Suitable Sealant	A sealant that is compatible with the quality of the water found in the well	Subsection 1(1) of the **Wells Regulation** For the purposes of this manual the term "grout" has the same meaning as suitable sealant. See also definition of "Sealant" and "Bentonite" in this table

Term	Definition	Further clarification
Test Hole	A well that, (a) is made to test or to obtain information in respect of groundwater or an aquifer, and (b) is not used or intended for use as a source of water for agriculture or human consumption	Subsection 1(1) of the **Wells Regulation**
Tremie Pipe	A pipe or tube with an inner diameter that is at least three times the diameter of the largest particle of material to pass through it and that is used to conduct material to the bottom of a hole, including a hole containing standing water	Subsection 1(1) of the **Wells Regulation** When used, a tremie pipe includes a float shoe or other similar devices if they are used to conduct material to the bottom of a hole. For clarification with respect to a tremie pipe, a pipe or tube means a long, hollow (empty space) cylinder.
Tribunal	Means the Environmental Review Tribunal	Subsection 1(1) of the *Ontario Water Resources Act*
Waters	A well, lake, river, pond, spring, stream, reservoir, artificial watercourse, intermittent watercourse, groundwater or other water or watercourse	Subsection 1(1) of the *Ontario Water Resources Act*
Well	A hole made in the ground to locate or to obtain groundwater or to test or to obtain information in respect of groundwater or an aquifer, and includes a spring around or in which works are made or equipment is installed for collection or transmission of water and that is or is likely to be used as a source of water for human consumption	Subsection 1(1) of the *Ontario Water Resources Act* There are three parts to the definition: 1) a hole used to locate or obtain groundwater is a well 2) a hole to test or obtain information with respect to groundwater or an aquifer is a well 3) a spring (natural groundwater discharge at ground surface) where works or equipment are installed and where the water will, or is likely to be used for human consumption is a well. The **Wells Regulation** exempts certain types of wells. The exempt wells are: trench, pond, ditch, reservoir, lagoon, artificial wetland, canal, tile drain and wick drain. If a hole is advanced or excavated to test or obtain information with respect to an aquifer or groundwater but the hole does not locate groundwater (i.e. a dry hole), the hole is still considered a well.

Term	Definition	Further clarification
		When dealing with earth energy (geothermal) systems it is important to consider the following: • In a geothermal system identified as an open loop system (or aquifer thermal energy storage system), groundwater is usually taken from a hole into a heat exchanger or heat pump. This hole meets the definition of a "well." • If water is discharged back from the heat exchanger or pump to the aquifer through another hole, then the hole is also considered a "well." Sometimes the same hole is used to take groundwater and discharge the water back into the aquifer in an open loop system. This hole meets the definition of a "well." • If the hole is advanced or excavated to locate or obtain groundwater but the hole does not locate groundwater (i.e. a dry hole), the hole is still considered a "well." If the earth energy (geothermal) system is considered a closed loop system and a person conducts a test (including a short duration pumping test or hydraulic conductivity test) on the groundwater in the hole, then the hole is a "well." In some cases a test may include a small pumping test to determine if the rate of groundwater flow during drilling or development will exceed 50,000 litres per day, and to ensure compliance with the Permit To Take Water requirements found in Section 34 of the *Ontario Water Resources Act*. Some earth energy (geothermal) closed loop systems use groundwater to transfer (i.e. conduct) energy to and from the heat transfer fluid. If the person is looking for, or obtaining information about, groundwater in the holes, for these systems, then the holes are considered "wells." For further information on earth energy (geothermal) systems please see the technical bulletin titled *Constructing Earth Energy Systems in Ontario* at http://www.ene.gov.on.ca/publications/7219e.pdf

Term	Definition	Further clarification
Well Contractor Licence	A licence referred to in section 39	Subsection 35(1) of the *Ontario Water Resources Act* A licence issued by the Director that authorizes the holder to engage in the business of constructing wells. See Chapter 3: *Well Construction Licences: Obtaining, Maintaining & Exemptions*
Well Technician Licence	A licence referred to in section 43	Subsection 35(1) of the *Ontario Water Resources Act* A well technician licence is a licence of a prescribed class issued by the Director that authorizes the holder to work at the construction of wells. There are five different classes of well technician licences each authorizing different well construction activities. See Chapter 3: *Well Construction Licences: Obtaining, Maintaining & Exemption*
Well Owner	The owner of land upon which a well is situated and includes a tenant or lessee of the land and a well purchaser	Subsection 1(1) of the **Wells Regulation** This means all three types of person; owner of land, tenant/lessee and well purchaser. In some cases multiple parties are responsible for maintaining or abandoning a well. Can mean an individual or individuals including corporations. Obligations from the person constructing the well to the well owner are as follows: • Notify of mineralized water and natural gas occurrences • Provide with well record Obligations of the well owner are as follows: • Maintain the well as required • Abandon the well where required • Provide written consent where required (e.g. during disinfection)

Term	Definition	Further clarification
Well Purchaser	A person who enters into a contract for the construction of a well with a person who is engaged in the business of constructing wells	Subsection 1(1) of the **Wells Regulation** A well purchaser is not a person constructing a well. Can mean an individual or individuals including corporations. Obligations from the person constructing the well to the well purchaser are as follows: • Notify of mineralized water and natural gas occurrences • Provide with well record • Provide with an information package • Provide with a water sample where required • Measure the depth of the well where required Obligations of the well purchaser are as follows: • Maintain well as required • Abandon well where required • Provide written consent where required (e.g. during disinfection)
Well Record	A form supplied by the Ministry for recording information about a well during construction or abandonment of the well	Subsection 1(1) of the **Wells Regulation**
Well Screen	Perforated pipe or tubing, unsealed concrete tiles or other material installed in a well to filter out particulate matter and form the water intake zone	Common drilled well screens are manufactured with specific slot sizes to prevent the formation's materials from entering the well. Persons constructing wells can slot or perforate casings to create well screens or install concrete casings with unsealed joints to create well screens. For new well construction, where the person uses concrete tiles as well casing and well screen, the well screen begins at the first unsealed joint in the concrete tiles and ends either at the bottom of the unsealed concrete tiles or any gravel or sand installed below the tiles in the excavated hole.

Term	Definition	Further clarification
Well's Structural Stage Completion	A well's structural stage is complete on the day on which the well is capable of being used for the purpose for which it was constructed but for (a) compliance with Section 15; (b) the installation of a pump, or (c) any alterations necessary to accommodate pumping, monitoring, sampling, testing or water treatment equipment	Subsection 1(3) of the **Wells Regulation** Thus the structural stage of a new well is complete after all of the following have been completed: • The well casing and well screen have been installed • The annular space has been filled • The control device has been installed on any flowing well • The well has been developed • The well yield has been tested, and • The well tag has been affixed to the well If a well is being altered (other than a minor alteration or pump installation), such as installing a liner or casing sleeve in a well, the person has structurally disabled the well from being used for the purpose for which it was constructed. After the alteration has been completed on the well, the well is again capable of being used for the purpose for which it was constructed. A person must then disinfect the well (see Chapter 8: *Well Disinfection*) and complete a well record (see Chapter 13: *Well Records, Documentation, Reporting & Tagging*). This term does not apply to well abandonment because the well is not capable of being used after it has been properly plugged and sealed.

Table 2-2: Other Terms in Addition to those Defined in the Wells Regulation

The terms described in Table 2-2 are for the purposes of providing clarification with respect to the **Wells Regulation** and may have other meanings in different contexts or in relation to other legislation. Unless otherwise indicated, they are derived from the ordinary dictionary meaning of the word.

Additional terms can be found in the Glossary at the end of this manual.

Term	Description	Further clarification
Agriculture	For clarification purposes, "agriculture" is defined in the *Labour Relations Act* and the *Agricultural Employees Protection Act*. "Agriculture" includes farming in all its branches, including dairying, beekeeping, aquaculture, silviculture and horticulture. Agriculture includes the raising of livestock including non-traditional livestock, furbearing animals and poultry, the production, cultivation, growing and harvesting of agricultural commodities, including eggs, maple products, mushrooms and tobacco, and includes any practices performed as an integral part of an agricultural operation.	The *Nutrient Management Act* also provides a definition for the term "agricultural operation." An "agricultural operation" includes: • Draining, irrigating or cultivating of land • Growing, producing or raising farm animals • The production of agricultural crops including greenhouse crops, maple syrup, mushrooms, nursery stock, tobacco, trees and turf grass • The production of eggs, cream and milk • The operation of agricultural machinery and equipment • Ground and aerial spraying • The management of materials containing nutrients for farm purposes • The processing by a farmer of the products produced primarily from the farmer's agricultural operation • Activities that are a necessary but ancillary part of an agricultural operation such as the use of transport vehicles for the purposes of the agricultural operation • Any other agricultural activity prescribed by the regulations under the *Nutrient Management Act*, conducted on, in or over agricultural land

Term	Description	Further clarification
Breakaway Guide	A device that aids in proper alignment of the casing when using a cable tool rig by centering the casing. It must not impair the quality of the water with which it comes into contact and must be placed 2 m (6.5') above the bottom of the casing.	The breakaway guide is placed 2 m (6.5') from the bottom of the leading casing during installation.
Clean	The word "clean" is used in different contexts in the regulation. With respect to equipment, clean means all visible dirt, debris and material have been removed. With respect to water, clean means water that will not interfere with the reaction to make a bentonite, concrete or cement slurry as recommended by the manufacturer and will not impair the well water. With respect to sand or gravel material, clean means that it should at least: • be washed with clean water to remove finer textured material, and • not cause an impairment of the well water	When installing any type of equipment in a well, it is a best management practice that the equipment is not only clean but also disinfected. When installing clean sand or gravel, it is a best management practice to meet the parameter concentrations of Table 1 in Soil, Groundwater and Sediment Standards for Use under Part XV.1 of the *Environmental Protection Act,* July 27, 2009[1] .Online resource available at: http://www.ene.gov.on.ca/envision/env_reg/er/documents/2009/010-4642%20Standards.pdf
Clear	All debris, including well cuttings and drilling fluids, have been removed from the well and well water; and the water is transparent or unclouded. This does not mean without any naturally occurring colour associated with the well water.	For example, groundwater can turn an orange colour where naturally occurring iron is present in the groundwater and formation. Groundwater can turn a black colour where naturally occurring iron sulphide is associated with the groundwater. Both of these samples could be "clear" for the purpose of the well development requirements in the Wells Regulation
Commercially Manufactured Vermin-proof Well Cap	A cap that creates a vermin-proof seal at the top of the well. A typical cap consists of top and bottom pieces with a rubber gasket in between. The bottom piece is connected to the well casing. The top piece is fastened to the bottom piece. The cap contains a port to house an electrical conduit or plug, as applicable. Also, the cap contains screened and shielded air vents.	Can also mean a sanitary well seal. See Chapter 9: *Equipment Installation*, "Well Caps and covers," for more information.

[1] Government of Ontario. July 27, 2009 *Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act*. Available at URL: http://www.ene.gov.on.ca/envision/env_reg/er/documents/2009/010-4642%20Standards.pdf

Term	Description	Further clarification
Contaminant	As guidance and for the consideration of the person installing a well, "contaminant" means any solid, liquid, gas, odour, heat, sound, vibration, radiation or any combination of the above resulting directly or indirectly from human activities that causes or may cause an adverse effect. (As per *Environmental Protection Act*, R.S.O. 1990. c. E 19 (EPA), S.1 "Source of contaminant" means anything that discharges into the natural environment any contaminant (As per the *Environmental Protection Act*, R.S.O., 1990. c E 19 (EPA) ss 1(1)).	Means the actual source of the contamination and not the pathway that a plume of contaminants would take from the source through the overburden and/or bedrock. Assessing and determining potential sources of contaminants that fit the definition of source of contaminants is dealt with on a case by case basis. A source of contaminants list includes but is not limited to the following: • All components of a sewage system under the *Building Code Act*, the *Ontario Water Resources Act* or the *Environmental Protection Act* • A farm animal feed lot • An animal manure pile • A barn and barnyard • A lagoon • An underground or above ground storage tank and lines that are designed to hold and move petroleum hydrocarbons, volatile organic compounds, polychlorinated biphenyls, phenols and other organic chemicals • An open or closed hazardous or non hazardous landfill or dump • A sewer line • A pond • Fertilizers, pesticides, herbicides and other chemical storage areas • Liquid or solid waste transfer facilities • Sewage sludge and biosolid waste spreading and irrigation sites • Winter sand and salt storage facilities
Contaminated Area or Site	Means an area that contains a contaminant. See definition of "contaminant".	
Double Walled Casing	As guidance to a person constructing a new well, a double walled casing in the **Wells Regulation** includes an inner casing within an outer permanent casing. The outer casing must surround the inner casing for part or all of the inner casing's length.	The inner casing, or casings, can extend above the top of outer casing or can extend below the bottom of the outer casing. The annular space between the casings in a new well must be sealed with suitable sealant to prevent the entry of surface water and other foreign materials.

Term	Description	Further clarification
Driven Point	A solid point or cone that is driven into the ground and that does not include a cutting shoe. This is also commonly referred to as a drive point.	Driven point construction method means a method that uses a solid point or cone that is driven into the ground. This does not include a cutting shoe unless a solid point is installed on an inner rod. For example, the type of machinery that can be used to drive the point into the ground can include direct push technology, rotary, percussion, pneumatic hammers, sonic, non-powered manual methods, and cone penetration testing equipment.
Free Chlorine Residual	The amount of chlorine available as dissolved gas (Cl_2), hypochlorous acid (HOCl), and hypochlorite ion (OCl^-), that is not combined with ammonia (NH_3) or other compounds in water.	The *Procedure for Disinfection of Drinking Water in Ontario (As adopted by reference by Ontario Regulation 170/03 under the Safe Drinking Water Act)*[2] by the Ministry of the Environment provides helpful definitions for free (available) chlorine residual, total chlorine residual and combined (available) residual chlorine in footnotes 4, 5 and 6 on Page 6. Online resource available at: https://www.ontario.ca/drinkingwater/stel01_046942.pdf
Free of Sand (Essentially Sand Free)	Sand free water or essentially sand free water is water from a new well that has been developed and is producing water that is free and clear of any fine grain materials, such as clay, silt, or sand.	
High Yield Well	A well that can yield a rate of more than 60 litres per second could be considered a high yield well.	
Lagoon	May include an engineered excavation designed to hold waste or wastewater or in some cases allow for the exfiltration of the waste.	Lagoons are exempt from Sections 36 to 50 of the *Ontario Water Resources Act* and the **Wells Regulation**; however, they are subject to approval instruments under the *Ontario Water Resources Act* or the *Environmental Protection Act.*
Licensee	Holder of a well contractor licence or a well technician licence, as the case requires.	

[2] Ministry of Environment. June 4, 2006. (Originally dated April 16, 2003, First Revision June 1, 2003) *Procedure for Disinfection of Drinking Water in Ontario (As adopted by reference by Ontario Regulation 170/03 under the Safe Drinking Water Act): Second Revision.* PIBS 4448e01. Available at URL: https://www.ontario.ca/drinkingwater/stel01_046942.pdf

Term	Description	Further clarification
Log of Overburden and Bedrock Materials	A log of overburden and bedrock materials or geologic log is required to be recorded on a well record. The Ministry provides instructions on how to make general observations and complete the log of overburden and bedrock materials intersected by the hole or excavation.	
Mastic Material	Mastic material is a preformed, manufactured material used to seal the joints between two concrete casing sections that: • Remains pliable and waterproof, • Is approved for potable water use by the NSF International Standard 61. (Search NSF Certified Drinking Water System Components online: http://www.nsf.org/Certified/PwsComponents/)	It is commonly made of a bitumen or butyl rubber sealant product. As a best management practice, it should at the least meet the ASTM C990M-06[3] standard titled: *Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants*.
Natural Gas	Natural gas or other gas is a gas produced from a well that has the potential to create conditions for explosions, poisoning, fire, asphyxiation or other adverse effects at the well site, within the water distribution system connected to the well or within buildings connected to wells. Some problematic gases that have been found in wells in Ontario include methane, hydrogen sulphide, propane, butane, benzene, carbon dioxide and other hydrocarbon based gases.	If natural gas is detected it must be immediately reported to the Director (Spills Action Centre at 1-800-268-6060), well purchaser and well owner.
Original ground surface	The surface of the ground at the well site immediately prior to the time the well construction or well abandonment activities take place.	
Overdrilling	Re-drilling an existing well using a drill bit that is larger than the diameter of the existing well casing or hole. The drilling operation reams (or rips) out the existing well's casing and annular seal	The technique is typically used to remove and install new well casing in a well rehabilitation operation or used to plug and seal a well.
Permanent	The word permanent means a one time installation that is intended to last indefinitely.	

[3] ASTM Standard C990M, 2006. "*Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants*," ASTM International, West Conshohocken, PA, 2003, DOI: 10.1520/C0990M-06, www.astm.org.

Term	Description	Further clarification
Potable Water	Water that meets or exceeds the Drinking-Water Quality Standards found in Regulation 169/03 as amended under the *Safe Drinking Water Act*.	
Property	A property is a piece of real estate owned by an individual or a corporation. An example of a property would be a piece of land owned or deeded to a person. Another example of property would be an entire roadway owned by a road authority.	
Recommended Pumping Rate	The estimated sustainable yield of the well based on the well yield test.	The recommended pumping rate will reflect the efficiency of the well screen (if present), the development of the well and the nature of the formation (aquifer) and should allow for a sufficient safety margin. The recommended pumping rate should be calculated to prevent water shortages and formation collapse around a well screen. The person conducting the well yield test must report the recommended pumping rate on the well record.
Reservoir	An artificial lake used for the storage and regulation of water.	Reservoirs are exempt from Sections 36 to 50 of the *Ontario Water Resources Act* and the **Wells Regulation.**

Term	Description	Further clarification
Routine Repair	A routine repair or routine maintenance on a well occurs when a person is following a sequence of actions regularly followed or a regular procedure on a well	An example of routine maintenance may be shock chlorinating the well water two or three times a year. The following are NOT considered to be routine repairs or maintenance: • Adding well casing extensions • Deepening a well • Replacing a casing • Installing a well screen in a well • Pulling and installing pumps and waterlines from wells for drinking uses • Changing pitless adapters attached to well casing
Slot Number	Manufacturers designate slot openings on a manufactured well screen by a number. The number matches the width in the slot openings in thousandths of an inch. For example a number 10 slot is an opening of 0.010" (which is converted to 0.25 mm). For smaller diameter well screens covered by wire mesh, manufacturers designate mesh number openings by a gauge number instead of a slot number. For example a number 10 slot equals a gauge number 60[4].	
Slurry	A mixture of liquid, especially water, and any of several divided substances, such as cement or clay particles.	

[4] Sterrett, Robert J. 2007. *Groundwater and Wells: Third Edition*. Johnson Screens/a Weatherford Company, St. Paul Minnesota. Pp. 395-398.

<table>
<tr><th>Term</th><th>Description</th><th>Further clarification</th></tr>
<tr><td>Useful Aquifer</td><td> An aquifer is defined as a water-bearing formation that is capable of transmitting water in sufficient quantities to serve as a source of a water supply. For the purposes of the Wells Regulation the terms “useful” and “aquifer” are considered qualitative terms that are applied on a case by case basis. The term “useful” in relation to aquifer could mean: A formation that yields sufficient supplies of water;
The water quality has to be suitable for the person’s purposes;
A material associated with the formation, such as a natural gas, has to be suitable for the person’s use;
The depth of the aquifer is such that it is economically feasible to drill, install devices and/or install pumping equipment to obtain the aquifer’s groundwater; or
The quality of the water in the aquifer is such that it is economically feasible to install treatment devices to obtain suitable water.</td><td>The Wells Regulation requires that a new well be at least 6 m (20′) deep, unless the only useful aquifer available necessitates a shallower well, in which case the well must be at least 3 m (10′) deep.</td></tr>
</table>

<table>
<tr><th>Term</th><th>Description</th><th>Further clarification</th></tr>
<tr><td>Water Intake Zone</td><td> The location of a well screen and installed sand or gravel material beside and below the well screen is considered the water intake zone of a well. Some wells are constructed with casing into overburden deposits. The bottom of the casing is completely open. Sometimes coarse material such as gravel or sand is placed below the open casing which is typical of large diameter dug and bored wells. In this type of well construction, any installed sand and gravel below the well and the open bottom area of the well casing is considered to be the water intake zone. In other situations wells are constructed with casing into bedrock deposits. In many cases, the hole below the casing is open in the bedrock (“open hole”). In these environments, the bedrock will typically be sufficiently strong enough to not collapse into the open hole. The open hole is designed to intersect one or more groundwater bearing bedrock fractures that will supply groundwater to the well. Thus, the entire open portion of the well below the well casing is considered a water intake zone. </td><td></td></tr>
<tr><td>Water Producing Zone</td><td>The meaning of “water producing zone” is understood differently depending on the well construction and formation. The following can be considered a water producing zone:
A well screen
A water intake zone at the bottom of an open well casing completed into an overburden formation
A bored well using concrete tiles with unsealed joints may encounter groundwater in two separate formations separated by a confining formation. Both groundwater producing formations are considered two separate water producing zones in the well.
A groundwater bearing fracture intersected by a well where the bottom portion of the well is constructed as an open hole in the bedrock.</td><td></td></tr>
</table>

Term	Description	Further clarification
Waterproof	"Waterproof" and "watertight" have the same general meaning.	
Watertight	Watertight means closely sealed, fastened or fitted so as to prevent the passage of water. A person should not be able to observe water movement through a joint, seam, seal or material using an appropriate performance test for the material. In the case of a watertight connection, well cover or flush mounted cover, "watertight" means a person cannot visually observe water or other foreign materials leaking or moving through any portion including the joint of the cover or connection.	See "Sealant" in Table 2-1 for further clarification on watertight materials. Most pipe is taper threaded to provide water tight joints.
Weathered Bedrock	Weathered unconsolidated rock in the basal subsoil or highly fractured rock commonly found above the competent (solid) bedrock. Based on its characteristics and the behaviour of groundwater in weathered bedrock, unconsolidated rock in the basal subsoil is generally considered as part of the overburden rather than as bedrock.	
Well Abandonment	The circumstances and timeframes in which a well must be abandoned and the requirements to be complied with when abandoning a well. Well abandonment and the activities associated with well abandonment are not considered to be "constructing a well" or "well construction activities."	
Well Development	A method, such as surging or blowing, used to do the following: • remove any water or drilling fluid introduced during well construction, • stabilize the filter pack and formation material around the well screen, • minimize the amount of fine grained material entering the well; and • improve the well efficiency and inflow of water into the well.	

Term	Description	Further clarification
Well Opening	The open area within the well casing or an excavation from the ground surface to at least 2 metres below the ground surface at the site of an abandoned well. If an excavator is used to remove well casing during a well abandonment (plugging and sealing), the well opening can be larger than the diameter of the well.	During the plugging and sealing of a well, the entire well opening must be filled with bentonite chips, pellets, granules or powder. The bentonite must be at least 0.5 to 1.5 metres thick in the well opening. The remainder of the well opening must be filled with soil cover or other material more in keeping with the surface material immediately adjacent to the well opening, to prevent inadvertent or unauthorized access.
Well Pit	An enclosed structure located at and below the ground surface that houses the top of the well and any associated pumping equipment. The well pit: • Protects the well from outside environmental conditions such as the prevention of waterline freezing, surface water runoff and other foreign materials, and • Allows access to the well from the land surface for well and pumping system maintenance.	
Well Production Rate	The well production rate is the estimated maximum sustainable yield of the well water based on the well yield test.	The person conducting the well yield test must report the well production rate on the well record.
Well Tag	An identification tag with a unique alphanumeric identifier obtained from the Ministry to be affixed to the outside of or near the well casing.	The tag links the well in the field with the well record.
Well Yield	The well yield is the volume of water discharging from a well over a period of time.	

3. Well Construction Licences: Obtaining, Maintaining & Exemptions

Chapter Table of Contents

Chapter Tables

Chapter Description

This chapter provides an explanation of the requirements related to licensing for well construction activities. Licensing is a process that sets minimum requirements for, experience, knowledge, and familiarity with well construction in Ontario. Well contractor licences are required by a person or partnership or company that engages in the business of well construction. Well technician licences of different classes are required for individuals who work on the construction of wells, unless they are exempt. There are supervision requirements for assistant well technicians who work with well technicians. For activities that are considered to pose a lower environmental risk, exemptions to licensing have been created. There are also requirements for the person abandoning the well (often the well owner) to hire a holder of a well contractor licence unless s/he is exempt.

Regulatory Requirements – Licences

Relevant Sections – The Wells Regulation

Exemptions – Section 1.0.1-1.0.3

Shallow Works – Section 1.1

Well Contractor Licence – Sections 2 -4

Well Technician Licence – Sections 5-7

Examination – Section 8

Continuing Education – Well Technicians – Section 8.1

Assistant Well Technician – Sections 9-10

THE REQUIREMENTS – EXEMPTIONS PLAINLY STATED

Well Contractor Licence

A person, partnership or company engaging in the business of well construction is required to obtain and maintain a well contractor licence unless exempt under the **Wells Regulation**.

Well Technician Licence

A person working at well construction is required to obtain and maintain a well technician licence of a prescribed class unless exempt under the **Wells Regulation** or the *Ontario Water Resources Act*. The prescribed classes are shown in "Well Technicians – Licence Classes," on page 11 of this chapter. Details on requirements to obtain and maintain licences, including continuing education, are discussed in the section titled "Continuing Education for a Well Technician Licence Holder" on page 18 of this chapter.

Assistant Well Technician (Helper/Labourer)

Without Identification Card

An assistant well technician without an identification card is exempt from requiring a well technician licence if the assistant well technician is supervised by a holder of a well technician licence, of the correct class of licence for the well construction activity, who is present at the site at all times.

With Identification Card

An assistant well technician with an identification card is exempt from requiring a well technician licence when working at the construction of wells on behalf of the licensed well contractor named on the card if:

- the expiry date on the card has not yet been reached,
- s/he carries the card and produces it on the request of an employee or agent of the Ministry, and
- s/he is supervised by the holder of a well technician licence, of the correct class of licence for the well construction activity, who is available to be called to the site within one hour.

A person exempt from the Class 5 well technician licence (e.g. *Professional Engineer* (P. Eng), *Professional Geoscientist* (P. Geo), and Certified Engineering Technologist (CET)) cannot supervise another employee doing Class 5 well construction activities. The exempted professional can supervise the other employee if either the exempted professional or the other employee has a Class 5 well technician licence.

Exemptions – Construction Activities

Sections 36 to 50 of the *Ontario Water Resources Act*, including licensing requirements, and the **Wells Regulation** do not apply to any of the following activities that are part of the construction of a well:

- Inspecting the well using equipment that is not left unattended in the well.

  Examples of such equipment include: video or a down the hole camera.

- Monitoring, sampling or testing the well using equipment that,
  - is not used to test the yield of the well or the aquifer, and is not left unattended in the well, or
  - is not used to test the yield of the well or the aquifer, and was previously installed in the well.

  Examples of such equipment include: a water level indicator to measure water levels, a small submersible pump or inertial pump to sample groundwater and conductivity, dissolved oxygen and pH meters to test groundwater.

- Installing equipment for monitoring, sampling or testing a test hole or dewatering well, unless,
  - the installation of the equipment involves an alteration of the well, other than notching the top of the casing, or
  - the equipment is used to test the yield of the well or the aquifer.

  Examples of such equipment include: pressure transducers with dataloggers for monitoring and dedicated inertial pump tubing or bailers for sampling.

Well Technician Licence Exemption for Experienced Professionals

An experienced person who works for a licensed well contractor does not require a well technician licence for Class 5 activities (see "Class 5 - Monitoring, Sampling, Testing and Non-Powered Construction " on page 12 of this chapter) if the person:

- holds a licence, limited licence or temporary licence under the *Professional Engineers Act*,
- holds a certificate of registration under the *Professional Geoscientists Act*, 2000 and who is a practicing member, temporary member or limited member of the *Association of Professional Geoscientists* of Ontario, or
- is registered under Subsection 8(2) of the *Ontario Association of Certified Engineering Technicians and Technologists Act*, 1998, being chapter Pr7, and who is an ordinary member of the Association continued under that Act.

When undertaking activities as described in Class 5, persons exempted from the Class 5 well technician licensing requirement must either be employed by a duly licensed well contractor, or be a holder of a well contractor licence.

At the time of release of this document, a separate manual is being prepared for test holes and dewatering wells titled *Test Holes and Dewatering Wells: Requirements and Best Management Practices*. Clarification and definitions of the terms "test hole" and "dewatering well" can be found in Chapter 2: *Definitions & Clarifications*, Table 2-1.

Abandonment

Unless exempt by the **Wells Regulation**, when a well is being abandoned a person abandoning a well (often the well owner) must do the following:

- retain the services of a licensed well contractor, and
- ensure the contract requires a well technician licensed to construct the type of well being abandoned is used to abandon the well.

The person abandoning the well is exempt from the above requirement if the person who works at the abandonment of the well is:

- the owner of the land or is a member of the owner's household,
- working without remuneration (e.g. not being paid) for another person on land owned by the other person or by a member of the other person's household, or
- a person who holds a Class 1 well technician licence (drilling)

At the time of release of this document, a separate manual is being prepared for test holes and dewatering wells titled *Test Holes and Dewatering Wells: Requirements and Best Management Practices*. Please refer to the other manual for information on additional exemptions to abandoning some test holes and dewatering wells.

When a person is retained to work at the abandonment of a well, the person must be either employed by a duly licensed well contractor or be a holder of a well contractor licence unless exempt by the **Wells Regulation**. A well contractor licence is not required if the person abandoning the well retains the services of a person who holds a Class 1 (drilling) well technician licence.

It is not *who* a person is but *what activities* a person does at a well site that determine the need for a particular licence. See Table 3-1, on page 9 of this chapter for a summary of activities by licence class.

Unattended – This term means the person working on a well is no longer in control of, or watching, the specific well. For example, a person who does not properly cover the well and leaves the well site is considered to have left the well unattended. Leaving the well site can include leaving the property, working on another well while not being present at the original well or not being in control of the well site.

An example of leaving the well unattended would be a person who leaves the well site after installing monitoring or sampling equipment in a well. If the well equipment is left unattended, the licensing and the **Wells Regulation** exemptions cease to apply.

Previously Installed - Some monitoring equipment is allowed to be left unattended in wells because the equipment has been previously installed in the wells, for example, a pump and pumping equipment that have been installed in a well by a licensed well technician. The person can use the previously installed pump and pumping equipment to sample water from the well and be exempt from the licensing requirements in respect of sampling and monitoring in the *Ontario Water Resources Act*.

For the clarification of the terms "minor alteration" and "routine repair" see Chapter 2: *Definitions and Clarifications* Table 2-1 and Table 2-2 respectively.

Relevant Sections – Additional Regulations or Legislation

- *Ontario Water Resources Act,* R.S.O. 1990, Chapter 0.40 – Section 1
- *Ontario Water Resources Act,* R.S.O. 1990, Chapter 0.40 – Sections 35 to 50 inclusive

Table 3-1: Activities Permitted by Class of Well Technician Licence – Water Supply Wells & Test Holes and Dewatering Wells

Table Legend:

× – indicates that the activity is not permitted
✓ – indicates that the activity is permitted
✓ – indicates that the activity is permitted under specific circumstances and/or with restrictions
(W) – indicates that the installation of an inertial pump is permitted

Notes for Table 3-1 are found on page 10.

	Activities	No Licence Required	Class 5*	Class 4	Class 3** (Driving/Jetting Wells Only)	Classes 1 & 2
Water Supply Wells	**Inspect well**	✓ • Must not leave equipment unattended	✓	✓	✓ • Must not leave equipment unattended	✓ • Must not leave equipment unattended
	Monitor, sample or test well	✓ (W) • Must not leave equipment unattended or must use previously installed equipment • Equipment must not be used to test yield of well or aquifer	✓	✓	✓ • Must not leave equipment unattended or must use previously installed equipment • Equipment must not be used to test yield of well or aquifer	✓ • Must not leave equipment unattended or must use previously installed equipment • Equipment must not be used to test yield of well or aquifer
	Install pump (for purposes other than sampling)	×	×	✓	×	×
	Construct well	×	×	×	✓ • Driving or jetting only	✓ • Class 1 – drilling only • Class 2 – digging or boring
	Abandon well* **	×	×	×	✓ • If well was driven or jetted	✓ • Class 1 can abandon all wells • Class 2 can only abandon dug or bored wells

	Activities	No Licence Required	Class 5*	Class 4	Class 3** (Driving/Jetting Wells Only)	Classes 1 & 2
Test Holes & Dewatering Wells	**Inspect well**	✓ • Must not leave equipment unattended	✓	✓	✓ • Must not leave equipment unattended	✓ • Must not leave equipment unattended
	Install equipment to monitor, sample or test	✓ (W) • No alteration other than notching the top of casing • Equipment must not be used to test yield of well or aquifer	✓	✓	✓ • No alteration other than notching the top of casing • Equipment must not be used to test yield of well or aquifer (W)	✓ (W) • No alteration other than notching the top of casing • Equipment must not be used to test yield of well or aquifer
	Install pump (for purposes other than sampling)	×	✓	✓	×	×
	Construct well	×	✓ • Only with non-powered equipment	×	✓ • Driving or jetting only	✓ • Class 1 – drilling • Class 2 – digging or boring (augering)
	Abandon well* **	×	✓ • Only with non-powered equipment	×	✓ • If well was driven or jetted	✓ • Class 1 can abandon all well • Class 2 can only abandon dug or bored wells

* P. Eng, P. Geo and CETs are exempt from requiring this class of licence to do activities which fall under Class 5. Despite this exemption, the work must be done for a licensed well contractor.

**Class 3 licence only authorizes activities or the type of well specified in the licence (e.g. jetting/driving).

***Unless exempt, the person abandoning the well (often the well owner) must retain a licensed well contractor and must ensure that the contract between them requires a well technician licensed to construct the type of well that is being abandoned to be used to abandon the well. See Plainly Stated and Responsibilities of the Person Abandoning the Well for Abandonment Operations section in this chapter. See Chapter 13: *Well Records, Documentation Reporting & Tagging*, "Well Record Information" section, and Chapter 15: *Abandonment – How to Plug and Seal Wells* for further information on the person abandoning the well.

Licensing does not apply if the person doing the construction or abandonment work is the owner of land, a member of the owner's household or works for free for the owner of the land.

Key Concepts

Well Contractor Licence

No person shall engage in the business of well construction without a valid well contractor licence unless exempt under the **Wells Regulation**.

Construct – When used with respect to a well, this means bore, dig, drill or otherwise make, extend or alter. Construct also includes installing equipment in or connected to a well.

A well contractor licence permits the licence holder to operate a well construction business. Well contractor licences are issued to applicants whose experience and financial responsibility meet the Ministry's requirements. Well contractors are responsible for holding the required insurance and for ensuring that the *Ontario Water Resources Act* and the **Wells Regulation** are complied with. To physically construct wells, a licensed well contractor must hold a well technician's licence or employ licensed well technicians.

Well Technicians – Licence Classes

No person shall work at the construction of a well without a valid well technician licence of a prescribed class unless exempt under the **Wells Regulation** or the *Ontario Water Resources Act*.

There are five classes of well technician licences to allow a person to perform different construction activities on a well. Four of the five classes (1, 2, 4 and 5) of licences represent common well construction activities that use significantly different equipment or methods. A fifth class of well technician licence, called Class 3, allows the Director to issue a licence for a specialized method or piece of well construction equipment. The well technician licence classes under the **Wells Regulation** are as follows:

Class 1 - Well Drilling - a licence authorizing the holder to construct and supervise the construction of wells by means of well drilling equipment including the following:

- Rotary drilling equipment (e.g. standard, barber, reverse, air, mud and air percussion)
- Cable tool (e.g. churn drill and percussion drill)
- Diamond drilling equipment (e.g. rotary equipment used to construct wells that is commonly associated with mineral exploration)

Class 2 - Well Digging and Boring - a licence authorizing the holder to construct and supervise the construction of wells by means of digging with non-powered equipment or with a back-hoe or power shovel and by means of boring or augering equipment.

Class 3 - Other Well Construction - a licence authorizing the holder to construct and supervise the construction of wells, or a type of well described in the licence, by only the equipment or methods (e.g. sonic, direct push and rehabilitation) specified on the licence.

Class 4 - Pump Installation - a licence authorizing the holder to install or supervise the installation of pumps and related equipment in or connected to a well (e.g. installation of down the well systems for chlorination, pitless adapters and sanitary well seals).

A person, who is licensed as a Class 4 well technician, can extend or shorten well casing, construct a well pit (if allowed, see Chapter 9: *Equipment Installation*) or remove a well pit as long as the activity involves the installation of a pump and its associated equipment.

For example, the above licence allows a person to do the following on a drilled well:

- Remove a well pit around the top of a drilled well and remove waterlines and related associated equipment from an existing drilled well.
- Weld a new piece of well casing from the top of the existing drilled well casing to more than 40 cm above the land surface.
- Create a new hole in the well casing and fit the hole with a pitless adapter connection.
- Connect a horizontal pipe and a drop pipe with a submersible pump to a pitless adapter.
- Backfill the well opening with a suitable sealant that must withstand the weight of humans and vehicles.

A Class 4 well technician licence also allows the holder to install pumps and associated equipment into both the taking well(s) and recharge well(s) of an open loop geothermal earth energy system.

Class 5 - Monitoring, Sampling, Testing and Non-Powered Construction - a licence authorizing the holder to do the following:

- Install and supervise the installation of monitoring, sampling or testing equipment in a well, other than equipment used to test the yield of the well or the aquifer,
- Install and supervise the installation of pumps in a test hole or dewatering well for monitoring, sampling or testing purposes, and
- Construct and supervise the construction of test holes and dewatering wells by any method that does not use powered equipment.

A person who holds a Class 4 licence can do and supervise the installation activities found in the Class 5 licence. A person who holds a Class 1 or Class 2 licence can do and supervise the non powered construction activities found in the Class 5 licence.

Examples:

If a person is undertaking work covered by various classes, for example digging a well and installing a pump, then the person would require Class 2 and Class 4 licences.

If a person only has a Class 1 licence, the person cannot construct a dug well or install a pump. That person would require a Class 2 licence and Class 4 licence to perform this work.

Exemptions from Well Technician Licence

A person who works at the construction or abandonment of a well on land owned by the person or by a member of the person's household; or a person who works without remuneration for another person at the construction or abandonment of a well on land owned by the other person or by a member of the other person's household, is not required to hold a well technician licence.

Best Management Practice – Retain Experienced and Licensed Professionals to Construct and Alter a Well and Properly Abandon (Plug and Seal) a Well

Although the *Ontario Water Resources* Act and the **Wells Regulation** allow residential well owners to construct or abandon their own wells without a licence, the equipment, materials and expertise needed to comply with the requirements under the **Wells Regulation** far exceed the average well owner's abilities and resources. Well owners need to understand how to measure water levels and well depths and be able to calculate volumes of well water, chemical mixtures and material mixtures. For instance, if a residential well owner cannot properly calculate and mix chemicals, does not have the necessary equipment or cannot employ proper safety procedures s/he should not construct a well. If the owner did the work, then s/he would be responsible for meeting all of the requirements of the **Wells Regulation**. A skilled well technician with valid well technician licenses of the correct class, working for a well contractor with a valid well contractor licence, should be retained to construct or abandon any well.

Residential land owners and their families can work on wells on their own properties as long as no remuneration or financial exchange occurs. If the land owner is a business (corporation, partnership, sole proprietor), municipality or a provincial government agency, employees must have proper well technician licences to construct a well and the business or government agency must have a well contractor licence.

Abandonment

The person abandoning the well (often the well owner) is required to retain the services of a licensed well contractor for any well abandonment operation unless otherwise exempt under the **Wells Regulation**.

Licensing Requirements

Requirements for Obtaining Licences

Licensing requirements are set out in the **Wells Regulation** as follows:

- Requirements and obligations for a well contractor licence (Sections 2, 3, 4)
- Requirements and obligations for a well technician licence (Sections 5, 6, 7)
- Examination process for a well contractor licence and a well technician licence (Section 8)
- Continuing Education requirements for well technicians (Section 8.1)
- Requirements for an assistant well technician (Section 9)

Requirements for Obtaining a Well Contractor Licence

The requirements for obtaining a well contractor licence are as follows:

- Application forms for the licence and examination must be submitted and the applicable fees paid.
- The official representative of the company must be designated. The designated person(s) is (are) responsible to ensure that the *Ontario Water Resources Act* and the **Wells Regulation** are complied with.
- The applicant, partner or director must be a minimum age (18 years).
- Minimum insurance in a form approved by the Superintendant of Insurance must include:
    - $2,000,000 or more, for property damage arising out of any one incident, and
    - $2,000,000 or more, for the death of, or bodily injury to, any person who is not an employee of the licensee, for each such person.
- The contract of insurance may:
    - limit the insurer's liability under the contract of insurance arising out of any one incident to $5,000,000, and
    - provide that the insured is responsible for a set amount, up to $1,000, for each claim for which coverage is required.
- The Director requires the following supporting documentation to be submitted in conjunction with the licence application:
    - proof of the insurance, and
    - copy of the business licence or proof of the incorporation.
- An official representative of the company must pass a Ministry examination with a grade of 75% or better. (The examination includes relevant sections of the **Wells Regulation** and the *Ontario Water Resources Act*).
- Additional information may be required by the Director.

The well contractor licence applicant is not required to take training courses, but is required to pass a Ministry exam, have an official representative and hold valid insurance. In the event the business is a sole proprietorship (with single owner/operator) the owner is also required to obtain and maintain a valid well technician licence of a prescribed class (see requirements below) unless otherwise exempt under the **Wells Regulation**.

Responsibilities of a Well Contractor Licence Holder

The responsibilities of a well contractor licence holder are as follows:

- If the licence holder is a corporation or partnership, it must ensure at least one director, officer or partner is designated as the official representative of the licensee at all times. The official representative must be assigned the responsibility of ensuring that the **Wells Regulation** and the *Ontario Water Resources Act* are complied with.
- Possess and maintain the appropriate insurance as outlined above.
- Employ the appropriately licensed well technicians and/or licensed professionals.
- Ensure that the well technicians, other employees and agents comply with the requirements of the **Wells Regulation,** the *Ontario Water Resources Act* and any other applicable provincial legislation relevant to constructing a well.
- Submit a well contractor licence renewal application form, required information such as insurance and fee to renew the licence by March 31 of each year.
- Report, in writing, any change in information to the Director within ten (10) days of the change.

Requirements for Obtaining a Well Technician Licence (Class 1, 2, 3 or 4)

The requirements for obtaining a well technician licence (Class 1, 2, 3 or 4) are as follows:

- Submit the application form and pay the applicable licence fee.
- Successfully complete a course of study of at least 30 hours approved by the Ministry of the Environment. A transcript must be provided to the Ministry along with a completed application for the particular class of licence applied for.
- Have:
    - 4,000 hours of experience in the field working on well construction or helping at projects which must be relevant to the class of licence applied for (e.g. construction/abandonment of wells by means of well drilling equipment for a Class 1 licence, or installing or assisting with pump installation in or connected to a well for Class 4 licence), or
    - a combination of experience and other qualifications (e.g. licence from another province or jurisdiction, an approved degree or courses from a University or College) that the Director considers equivalent to 4,000 hours of experience.

  If another type of certification or education is held (e.g. pipe fitter licence, welding or electrical certificate or the 2 year Drilling and Blasting course at Fleming College) the full 4000 hours might not be required at the discretion of the Director.

- Be a minimum age (18 years).
- Pass a Ministry examination with a grade of 75% or better. (The examination includes relevant sections of the **Wells Regulation** and the *Ontario Water Resources Act*).
- Additional information may be required by the Director. For example, letters of reference are typically required to satisfy the Director as to the applicant's character, qualifications and ability.

Requirements for Obtaining a Well Technician Licence (Class 5)

If the applicant is:

- a member of the Association of Professional Engineers of Ontario as an engineer-in-training,
- a member of the Association of Professional Geoscientists of Ontario as a geoscientist-in-training, or
- a member of the Ontario Association of Certified Engineering Technicians and Technologists as a technician or technologist-in-training

Then s/he must do the following:

- Submit the application form and pay the applicable licence fee.
- Successfully complete a course of study of at least 15 hours approved by the Ministry of the Environment.
- Have:
  - o 500 hours of experience in the field working on well construction projects which must be relevant to the Class 5 licence, or
  - o a combination of experience and other qualifications (e.g. a licence from another province or jurisdiction, an approved degree or courses from a university or college) that the Director considers equivalent to 500 hours of experience.
- Be a minimum age (18 years).
- Pass a Ministry examination with a grade of 75% or better. (The examination includes relevant sections of the **Wells Regulation** and the *Ontario Water Resources Act*).

For additional information on the application process including formal education and training on licensing see the contact information in the “Tools for Well Construction Licences” section at the end of this chapter.

If the applicant is anyone other than a person described in the above section s/he must do the following:

- Submit the application form and pay the applicable licence fee.
- Successfully complete a course of study of at least 30 hours approved by the Ministry of the Environment.
- Have:
  - o 1,000 hours of experience in the field working on well construction or helping at projects which must be relevant to the Class 5 licence, or
  - o a combination of experience and other qualifications (e.g. a licence from another province or jurisdiction, an approved degree or courses from a University or College) that the Director considers equivalent to 1,000 hours of experience.
- Be a minimum age (18 years).
- Pass a Ministry examination with a grade of 75% or better. (The examination includes relevant sections of the **Wells Regulation** and the *Ontario Water Resources Act*).

Persons Exempted from Class 5 Licensing

A person who is a practicing, temporary or limited member of the Professional Engineers of Ontario (PEO); a practicing, temporary or limited member of the Association of Professional Geoscientists of Ontario (APGO); or an ordinary member the Ontario Association of Certified Engineering Technicians and Technologists (OACETT), may do work or supervise all construction activities described in a Class 5 licence without a licence if s/he works for a person who holds a well contractor licence. This means that the well contractor must have the minimum insurance coverage prescribed for well contractors. The licensed well contractor does not need to be on site when the P.Eng, P. Geo or CET is working.

A person exempt from the Class 5 well technician licence (i.e. P.Eng, P.Geo, CET) cannot supervise another employee doing Class 5 well construction activities. The exempted professional can supervise the other employee if either the exempted professional or the other employee has a Class 5 well technician licence.

Responsibilities of a Well Technician Licence Holder

The responsibilities of a well technician licence holder are as follows:

- Ensure that s/he works for a licensed well contractor or a provincial Ministry of the Crown.
- Ensure that s/he and any person under his/her supervision meet the requirements of the **Wells Regulation,** the *Ontario Water Resources Act* and any other applicable provincial legislation relevant to constructing a well.
- Ensure that s/he only works or supervises work as specifically authorized by the well technician licence that s/he holds.
- Ensure that s/he only supervises up to two pieces of well construction equipment at any one time. This number refers to the pieces of equipment and not necessarily the number of people a well technician can supervise.
- Have the well technician licence or a photocopy of the entire licence on site at all times during well construction activities and produce it upon request of an employee or agent of the Ministry.
- Report, in writing, any change in information to the Director within ten (10) days of the change.
- Submit an application form and the required fee to renew the licence by March 31 of each year.
- Return any assistant well technician identification card immediately to the Ministry, if s/he becomes a well technician.

Once a licence has been renewed, a minimum of 21 hours of continuing education in approved courses must be taken every three (3) years for renewal of a well technician licence that is identified as Class 1 to Class 4. A minimum of 14 hours of continuing education in approved courses must be taken every 3 years for renewal of a well technician licence that is identified as a Class 5.

Continuing Education for a Well Technician Licence Holder

For the purposes of the three (3) year continuing education course cycle, which starts the year of the first renewal, the applicant must successfully complete the Director approved courses within a period of time that:

- ends on the date the licence renewal application is submitted, and
- begins on the later of either:
  - January 1, three years prior to the year of licence renewal, or
  - the final day of instruction in a course that previously counted towards the continuing education requirement for a previous licence renewal and the course occurred in the calendar year three years before the licence renewal application is submitted.

The following provides examples:

1. A Class 1 well technician (driller), originally licensed in 2006, will renew the licence for the first time in 2007. The well technician must take a course or courses that are approved by the Director, totalling at least 21 hours, and prior to the 2010 licence renewal. In this example, the period for the continuing education started January 1, 2007. The last course must be successfully completed before the well technician submits the 2010 well technician licence application to the Director.
2. The same Class 1 well technician (driller), who applies for licence renewal in 2013, must take a course or courses, approved by the Director, totalling at least 21 hours prior to the 2013 licence renewal. In this example, the period for the continuing education starts January 1, 2010. The last course must be successfully completed before the well technician submits the 2013 well technician licence application to the Director.
3. The same Class 1 well technician (driller), who is applying for licence renewal in 2013, must take a course or courses, approved by the Director, totaling at least 21 hours prior to the 2013 licence renewal. The well technician took a:
   - 3-day course that started January 21, 2010 and ended January 23, 2010,
   - 2-day course that started February 1, 2010 and ended February 2, 2010,
   - 3-day course that started March 3, 2010 and ended March 5, 2010,
   - 2-day course that started March 3, 2012 and ended March 5, 2012, and
   - 1-day course on February 4, 2013.

In this example, the well technician counted the time for the January 21 to 23 and February 1 to 2, 2010 courses for a previous 2007 to 2010 continuing education cycle. The well technician did not count the time for the March 3 to 5, 2010 course for the previous 2007 to 2010 education cycle.

In this example, the 2010 to 2013 period for the continuing education could start January 23, 2010 (i.e. the last day of a course of instruction three years prior to the licence renewal) because the course was used for a previous continuing education cycle. This allows the well technician to use the hours obtained in the final day of the January course to count towards the 2010 to 2013 continuing education period. The February and March 2010, March 2012 and February 2013 courses can also be used by the well technician for the 2010 to 2013 continuing education period. The last course must be successfully completed before the well technician submits the 2013 well technician licence application to the Director.

In the case of a class 5 well technician licence, the minimum continuing education hours total at least 14 instead of 21 hours.

All well technician applications must be submitted to the Director before March 31 of each year in order for the licence to be continued after March 31 pending the Director's decision.

Continuing education courses are currently available through Fleming College and the Ontario Groundwater Association regional meetings. The Director has the discretion to approve other courses and set the criteria used to approve other courses.

Responsibilities of the Person Abandoning the Well for Abandonment Operations

Unless exempt by the **Wells Regulation**, when a well is abandoned, the person abandoning a well (often the well owner) must do the following:

- retain the services of a licensed well contractor, and
- ensure the contract with the licensed well contractor requires a well technician licensed to construct the type of well being abandoned is used to abandon the well.

The person abandoning the well is exempt from the above requirement if the person who works at the abandonment of the well is:

- the owner of the land or is a member of the owner's household,
- working without remuneration (i.e. not being paid) for another person on land owned by the other person or by a member of the other person's household, or
- a person who holds a Class 1 well technician licence (i.e. drilling).

Examples of which well technicians (i.e. class) can work on well abandonment are as follows:

- A well constructed by drilling equipment must be abandoned by a person who holds a valid Class 1 well technician licence.
- A well constructed by digging or excavation equipment must be abandoned by a person who holds either a valid Class 1 or Class 2 well technician licence.
- A person who holds a valid Class 3 well technician licence is allowed to work at the abandonment of a well originally constructed as specified on the well technician licence.
- A person who holds only a valid Class 4 well technician licence is not allowed to work at the abandonment of any well.
- A well constructed by drilling equipment within a well originally constructed by digging or boring equipment (e.g. dug well or well pit) must be abandoned:
    - by a person who holds a valid Class 1 well technician licence or
    - the dug portion of the well, or well pit, can be abandoned by a person who holds a valid Class 2 well technician licence and the drilled portion can be abandoned by a person who holds a valid Class 1 well technician licence. Both portions of the well must be properly abandoned.
- A well constructed by jetting or driving equipment within a well originally constructed by digging or boring equipment (e.g. dug well or well pit) must be abandoned:
    - by a person who holds a valid Class 1 well technician licence or
    - the dug portion of the well, or well pit, can be abandoned by a person who holds a valid Class 2 well technician licence and the driven/jetted portion can be abandoned by a person who holds a valid Class 3 well technician licence that allows him/her to construct driven/jetted wells. Both portions of the well must be properly abandoned.

The person abandoning the well (often the well owner) must ensure the person who works at the well abandonment must be either employed by a duly licensed well contractor, or be a holder of a well contractor licence unless exempt by the **Wells Regulation**. A well contractor licence is not required if the person abandoning the well retains the services of a person who holds a Class 1 well technician (drilling) licence.

Unless exempt, the person abandoning the well (often the well owner) must retain a licensed well contractor and ensure the contract with the well contractor requires a properly licensed well technician (see above in this section) to work at the abandonment of the well, even if the well is to be fully excavated. For example:

- An unlicensed general contractor cannot hire a licensed well technician who works for a licensed well contractor to supervise the abandonment of any well (including the complete excavation of a well) by the general contractor's employees.
- When a licensed well contractor sub-contracts other equipment and operators to abandon a well, the person abandoning the well must ensure that the contract requires the sub-contracted company and its employee(s) have valid well contractor and appropriate well technician licence(s).

See Chapter 13: *Well Records, Documentation, Reporting & Tagging* for further information on the person abandoning the well.

At the time of release of this document, a separate manual is being prepared for test holes and dewatering wells titled *Test Holes and Dewatering Wells: Requirements and Best Management Practices*. Please refer to the other manual for information on additional exemptions to abandoning some test holes and dewatering wells.

Requirements for an Assistant Well Technician

Assistant Well Technician with no Identification Card

An assistant well technician without an identification card is exempt from requiring a well technician licence if the assistant well technician is supervised by a holder of a well technician licence, of the correct class of licence for the well construction activity, who is present at the site at all times.

Assistant Well Technician with Identification Card

An assistant well technician with an identification card is exempt from requiring a well technician licence when working at the construction of wells on behalf of the licensed well contractor named on the card if:

- the expiry date on the card has not yet been reached,
- s/he carries the card and produces it on the request of an employee or agent of the Ministry, and
- s/he is supervised by the holder of a well technician licence, of the correct class of licence for the well construction activity, who is available to be called to the site within one hour.

Requirements for Obtaining an Assistant Well Technician Card

The requirements for obtaining an assistant well technician card are as follows:

- A licensed well contractor can apply to the Ministry for an identification card for an assistant well technician who has worked for the business a minimum of four (4) months.
- A licensed well contractor can apply to the Ministry for a new identification card for the assistant well technician if the card is about to expire.

There is no minimum age requirement for an assistant well technician or for obtaining an identification card set out in the **Wells Regulation**. However, employers must meet all applicable labour laws when employing assistant well technicians.

Requirements of an Assistant Well Technician Identification Card

The requirements of an assistant well technician identification card are as follows:

- An identification card issued to an assistant well technician has an expiry date that is not more than 36 months after the date of issue.
- An identification card must be returned by the holder of the identification card immediately, to the Ministry, if the holder is no longer an employee or agent of the licensed well contractor.
- An identification card must be returned by the holder of the identification card immediately, to the Ministry, if the holder obtains a well technician licence.

Ontario Water Resources Act – Grounds to Refuse New and Renewal Applications

Grounds for refusal to issue a new Well Contractor licence (Excerpted From Section 41 of the *Ontario Water Resources Act*)

A Director may refuse to issue a well contractor licence for the following reasons:

(a) The past conduct of the applicant or, where the applicant is a corporation, of its officers or directors indicates that the business of constructing wells will not be operated in accordance with the law and with honesty and integrity,

(b) The applicant or, where the applicant is a corporation, its officers or directors are not competent to engage in the business of constructing wells,

(c) The applicant or, where the applicant is a corporation, its officers or directors are not in a position to observe or carry out the provisions of Sections 35 to 50 of the *Ontario Water Resources Act*, the **Wells Regulation** or the licence, or

(d) The applicant or, where the applicant is a corporation, its officers or directors have been grossly negligent in carrying on the business of constructing wells under the authority of a licence issued under section 40 of the *Ontario Water Resources Act* or a predecessor of that section.

Grounds for refusal to renew a Well Contractor Licence (Excerpted From section 42 of the *Ontario Water Resources Act*)

A Director may revoke or suspend or may refuse to renew a well contractor licence for the following reasons:

(a) Any person has made a false statement in any material part of the application for the licence or a renewal of the licence or of any report, document or other information,

(b) The past conduct of the licensee or, where the licensee is a corporation, of its officers or directors indicates that the business of constructing wells has not been operated or will not be operated in accordance with the law and with honesty and integrity,

(c) The licensee is in breach of sections 35 to 50 of the *Ontario Water Resources Act* or the **Wells Regulation**,

(d) A change in the officers or directors of a corporation that is a licensee provides grounds for refusing to issue a well contractor's licence under clause 41(a)(b) or (d),

(e) The services that can be provided by the licensee have been misrepresented,

(f) The licensee is not competent to carry on or has been grossly negligent in carrying on the business of constructing wells, or

(g) The licensee is not in a position to observe or carry out the provisions of sections 35 to 50 of the *Ontario Water Resources Act*, the **Wells Regulation** or the licence.

Grounds for refusal to issue a new Well Technician licence (Excerpted From section 45 of the *Ontario Water Resources Act*)

A Director may refuse to issue a well technician licence where the Director is of the opinion, upon reasonable and probable grounds, that the applicant is not competent to carry on the activities that would be authorized by the licence.

Grounds for refusal to renew a Well Technician licence (Excerpted From section 46 of the *Ontario Water Resources Act*)

A Director may revoke or suspend or may refuse to renew a well technician licence for the following reasons:

(a) Any person has made a false statement in any material part of the application for the licence or a renewal of the licence or of any report, document or other information required by the *Ontario Water Resources Act*, **Wells Regulation** or any other Act or regulation that applies to the construction of wells,

(b) The licensee is in breach of sections 35 to 50 of the *Ontario Water Resources Act* or the **Wells Regulation**, or

(c) The licensee is not competent to carry on or has been grossly negligent in carrying on the activities that are authorized by the licence.

Penalties for Failing to Comply with Licensure Requirements

- General penalties for non-compliance with a requirement of the *Ontario Water Resources Act* or the **Wells Regulation** include a maximum fine of $50,000 for each day or part of day on which the offence occurs or continues for the first offence, $100,000 for each day or part of day on which the offence occurs or continues for second offence and imprisonment for up to one year.
- Corporate penalties for non-compliance with a requirement of the *Ontario Water Resources Act* or the **Wells Regulation** include a maximum fine of $250,000 for each day or part of day on which the offence occurs or continues for the first offence, $500,000 for each day or part of day on which the offence occurs or continues for second offence.

TOOLS FOR WELL CONSTRUCTION LICENCES

WELL INDUSTRY LICENSING

The following is intended as a brief guide for applicants to summarize the application submission process for a **new Well Contractor Licence and/or Well Technician Licence including applications to add a class to an existing Well Technician Licence.**

Ontario Regulation 903 under the *Ontario Water Resources Act* prescribes licensing requirements for activities associated with wells. If you require a copy of Regulation 903 or the relevant sections (35 to 50) of the *Ontario Water Resources Act*, please contact the Ministry's Public Information Centre at 416-325-4000 or 1-800-565-4923 or visit www.e-laws.gov.on.ca (type "wells" in the search bar).

A Well Contractor Licence is a business licence and entitles the holder to engage in the business of well construction only. It does not authorize the holder to work at the construction of wells. The actual work is required to be carried out by a licensed Well Technician with a valid licence of the proper prescribed class(es). Well Technicians are required to work under the authority of a Well Contractor Licence holder. Both licences are required for anyone who is both an owner of a well construction business and also the sole equipment operator of that well construction business.

The licences expire on March 31 following the year of issue. In order to renew the licence(s) and ensure continuation, a renewal application package must be submitted (application form, applicable fees, required documentation) prior to the expiry of the licence. The water well industry licensing application forms are available on the Government of Ontario Central Forms Site at www.forms.ssb.gov.on.ca (type "wells" in the search bar).

Every application (new or renewal) is reviewed in accordance with the Regulation and the approval of the application is dependent on the proper submission of all of the required information. Any requests or changes to the application file should be provided in writing.

It is an offence to provide false information on any application form or statement with respect to any matter made under the Act, or the regulations.

WELL CONTRACTOR LICENCE:

1. Application for Well Contractor Licence (Form 1 - 1987) - completed in full, dated and signed
2. Confirmation of valid Comprehensive General Liability Insurance as prescribed in the Reg. 903 for the duration of the licence period for well construction business:
   - Name of the Insured (as per the Insurance Policy)
   - Policy No.
   - Expiry Date (YYYY/MM/DD)
   - Name of Insurance Company
   - Name of Insurance Agent
   - Description of Insured Activities
   - Amount of Coverage
3. Copy of a VALID Master Business Licence (MBL) or Proof of Incorporation – the Well Contractor Licence to be issued in the business name of the insured operation. For details on how to register/renew your MBL, visit http://www.mgs.gov.on.ca (Services for Business / Gateway for Business) or contact ServiceOntario Toll Free at 1–800–361–3223. Note: MBL has to be renewed every five years.
4. Successful completion of MOE Exam, see **MOE Examination** for details
5. Payment of applicable fees, see **REQUIRED FEES** for details

NOTE: In case of partnerships and/or corporations, the official representative(s) designated for the Well Contractor as listed on the application must be a director, officer, or partner and be listed on the application for a Well Contractor Licence as well as on the official documentation i.e. Articles of Incorporation or Master Business Licence. Each designated official(s) must successfully complete the MOE examination.

WELL TECHNICIAN LICENCE (new, add-a-class):

1. Application for Well Technician Licence (Form 4 - 1993) - completed in full, dated and signed

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2. Proof of Successful Completion of an approved Course of Study, for course information visit www.welltechtraining.org or call Sir Sandford Fleming College at 1-888-269-6929. The pre-registration number is issued by MOE upon request (in writing).

3. Supporting information to substantiate relevant work experience as prescribed in the Reg. 903. Please consult Reg. 903 on number of hours of experience required. Information/documentation is required detailing nature of the work and how it qualifies the applicant for the licence and class(-es); and to clarify and/or detail the number of hours spent performing the activities, including any applicable overtime or additional employers where experience might have been gained. Memoranda or letters of reference from current or past employers (and/or clients for self-employed) should be provided stating in detail:
   - dates of employment including type of employment (full- / part-time, hours) and name(s) of employer(s)/well contractor(s);
   - duties and responsibilities relating to the licence and class(-es) requested:
     - **Class 1 - Well Drilling** (construction/ abandonment of wells by means of well drilling equipment including: rotary drilling equipment, cable tool and diamond drilling);
     - **Class 2 - Well Digging and Boring** (construction/abandonment of water wells by means of digging with non-powered equipment or with a back-hoe or power shovel and by means of boring or augering equipment);
     - **Class 3 - Other Well Construction: PLEASE SPECIFY** (type of equipment operated/ installed/ repaired/ methods, etc.);
     - **Class 4 - Pump Installation** (installing or assisting with pump installation in or connected to a well, type of equipment operated/ installed/repaired);
     - **Class 5 - Monitoring, Sampling, Testing and non-Powered Construction** (installing or assisting with installation of: monitoring, sampling, testing equipment in a well; pumps in a test hole or dewatering well; constructing or assisting with construction of test holes, dewatering wells by non-powered equipment);
   - consent/permission to contact the individual(s) who supervised the work;
   - copies of well records, if completed/applicable.

4. Successful completion of MOE Exam, see **MOE Examination** for details

5. Payment of applicable fees, see **REQUIRED FEES** for details

NOTE: Requirement for Class 5 applications - Proof of Association Membership, if applicable

MOE EXAMINATION:

1. Application for An Appointment to Take An Examination (Form 7 – 1990) - completed in full, dated and signed

2. Successful completion of MOE Exam

3. Payment of applicable fees, see **REQUIRED FEES** for details

All examinations are scheduled by appointment once exam application and applicable fees are received. Applicant is notified in writing via email or fax at least seven days prior to the examination date. An applicant who had an appointment for an examination that he or she did not try shall be deemed to have tried the examination and will be required to apply again.

REQUIRED FEES (Cheque or money order, Payable to "Treasurer of Ontario"):

1. Well Contractor Licence Application Fee: $10.00

2. Well Technician Licence Application (new or add-a-class) Fee (dependent on number of Classes requested): $10 for a licence application with one Class plus an additional $5 for each additional Class.

3. Examination Fee: $10.00

An administrative fee of $35.00 applies for any dishonored cheque payments including post-dated cheques.

Please direct any licensing inquiries/application package to the WATER WELL HELP DESK as indicated on the applications forms.

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4. Siting the Well

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Identifying the appropriate location for well construction will dictate the success or failure of any construction activity. Whether the goal is to find a water supply for potable, agricultural or industrial purposes, a comprehensive planning process will assist in identifying the right site for the well. This chapter provides guidance and minimum requirements for siting a well.

Regulatory Requirements – Well Siting

Relevant Sections – The Wells Regulation

Ontario

Location of Wells – Section 12(1) – (6)

Records – Single Well Record – Section 16.3

The Requirements – Plainly Stated

Ontario

The Wells Regulation requires the following when Siting Wells:

- Anyone constructing a new well, other than a test hole or dewatering well, must follow all requirements for siting a well;
- The site of a new well must meet the minimum horizontal separation distances from contaminant sources that are provided in Table 4-1 and Table 4-2; and
- Once a well has been constructed, the well location must be determined and indicated on the well record using a global positioning system (GPS) receiver, according to the instructions on the well record.

Table 4-1: Minimum Horizontal Separation Distances between Wells and Existing Sewage Systems*

	Well with watertight casing to a depth of ≥ 6m (19.7’)	Any other well[1]
earth pit privy	15m (50’)	30m (100’)
privy vault, pail privy	10m (33’)	15m (50’)
greywater system	10m (33’)	15m (50’)
cesspool	30m (100’)	60m (200’)
treatment units (such as a septic tank)	15m (50’)	15m (50’)
distribution pipe in a leaching or filter bed	15m (50’)	30m (100’)
holding tank	15m (50’)	15m (50’)

[1] includes a spring used as a source of water for human consumption

* Information provided from Ontario Building Code (Regulation 350/06 as amended) is current as of January, 2008

These separation distances apply to any future earth pit privy, privy vault, pail privy, greywater system or cesspool, and a treatment unit, a distribution pipe in a leaching or filter bed, septic tank or holding tanks that has not been constructed but for which a building permit has been issued.

Table 4-2: Minimum Horizontal Separation Distances between Wells and Sources of Contaminants Other Than Those Mentioned in Table 4-1

	Drilled Well with watertight casing that extends to a depth of more than 6 m (19.7’)	Any other well[1]
source of contaminants	15 m (50’)	30 m (100’)

[1] includes a spring used as a source of water for human consumption

Accessibility and Elevation

- A person constructing a new well, other than a test hole or dewatering well, as defined in the **Wells Regulation**, must locate (site) a new well so that it is:
    - accessible for cleaning, treatment, repair, testing, inspection and visual examination at all times before, during and after completion of construction of the well; and
    - at a higher elevation than the immediate surrounding area.

Relevant Sections – Additional Regulations or Legislation

Regulation 350/06 (Building Code) made under the *Building Code Act,* 1992 - Tables 8.2.1.5, 8.2.1.6A, 8.2.1.6B and 8.2.1.6C

Key Concepts

What to Consider When Siting a Well

Many different factors must be taken into account before choosing where to place or site the well, including the following:

- Natural elements - such as the topography (land surface) of the site, the flow of groundwater, or the location of the aquifer
- Potential sources of contamination - septic systems, chemical storage (see Chapter 2: *Definitions & Clarifications*, Table 2-2 “contaminant” for further clarification)
- Safety - presence of overhead power lines or buried utilities

Important Information to Know

The list below includes most, but not all of the information and tools that may be needed to help in the planning and siting of the well:

- Size and shape of the property, property elevations – a diagram or simple map – measuring tools as needed
- Location of natural features – trees, topography, etc.
- Location of all nearby surface water sources such as lakes, rivers and creeks
- Location of springs
- Diagram of the property indicating the slope and contours of land to help determine possible direction of the groundwater flow
- Location or planned location of structures and their purposes – barn, storage shed, house, etc.
- Location or planned location of septic or sewage system, underground or on the surface, fuel storage, and the status of existing system(s)
- Location of land application or storage of pesticides, herbicides, and fungicides, inorganic fertilizers, road salt and nutrients
- Distance to and location of any nearby roads, intersections, parking areas
- Location of electrical lines or other potential overhead or underground utilities or hazards
- Location of any previous or existing wells and status – depth, abandoned, by whom, why, when, etc.
- Planned property uses including future grading of the ground surface
- Planned water uses

- Information about geology and formations, aquifer types likely present (i.e. location, rock type and fracturing of any bedrock outcrops on the property or adjacent properties) from well records and/or area hydrogeological and geotechnical reports.
- Position of any features, structures and septic systems or other potential contamination sources on adjacent properties
- Position of wells on adjacent properties
- Accessibility issues to ensure the well is accessible for maintenance

Well construction may require additional approvals (e.g. certificate of approval or Permit to Take Water – e.g. flowing well discharging greater than 50,000 L/day). These approvals should be requested and obtained in advance of a well construction operation.

See "Tools for Siting the Well" on page 14 of this chapter for information and actions involved with site research and assessment.

Assessing and determining potential sources of contaminants is dealt with on a case by case basis.

A source of contaminants list includes but is not limited to the following:

- All components of a sewage system under the *Building Code Act* or *Environmental Protection Act,*
- A farm animal feed lot,
- An animal manure pile,
- A barn and barnyard used for domestic animals,
- A lagoon,
- An underground or above ground storage tank and lines that are designed to hold and move petroleum hydrocarbons, volatile organic compounds, polychlorinated byphenyls, phenols and other organic chemicals,
- An open or closed hazardous or non hazardous landfill or dump,
- A sewer line,
- A pond,
- Fertilizers, pesticides, herbicides storage and other chemical storage areas,
- Liquid or solid waste transfer facilities,
- Sewage sludge and bio-solid waste spreading and irrigation sites, and
- Winter sand and salt storage facilities.

For a more detailed description of "source of contaminant" see Chapter 2: *Definitions & Clarifications*, Table 2-2 "contaminant".

How to Assess Contamination Flow

Contaminants, such as bacteria, hydrocarbons and chemicals, can move easily through soil and even more easily through fractured bedrock. Where fractured bedrock occurs at or near the land surface, the potential for contaminants to get into the groundwater is high.

When contaminants move through soil and fractured rock they generally follow the flow of the groundwater. Therefore, it is important to always take the groundwater flow pattern into consideration when siting a well.

Groundwater flow direction can be complex to determine, but the flow often follows the contour or slope of the land and typically discharges into surface water bodies. Figure 4-1 demonstrates potential risks and the flow of contaminants into and with groundwater.

Scenarios where groundwater flow may be complex include the following:

- Multiple shallow and deep aquifers are present and have different groundwater flow directions,
- Preferential flow pathways exist, such as buried hydro or gas lines,
- Many wells pump groundwater from a single aquifer, and
- Wells are present that pump large volumes of groundwater, at a high rate, from an aquifer.

In these and other complex scenarios, the flow of the groundwater is best determined by a *Professional Engineer* or *Professional Geoscientist*.

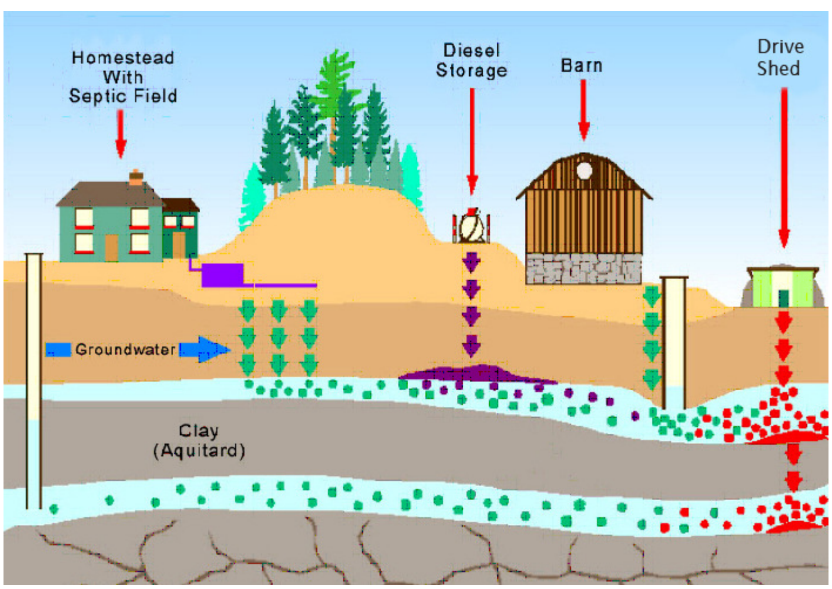


Figure 4-1: Risk of Contamination[1]

[1] Agriculture and Agri-Food Canada. 2003. *Best Management Practices: Water Wells* (BMP12).

Selecting the Site

After the potential sources of contamination and groundwater flow direction have been identified, the well must be sited using the minimum setback distances (see Plainly Stated in this chapter). In addition, the following best management practices are recommended to protect well water quality.

Best Management Practice – Siting the Well Upgradient of Sources of Contamination

Where possible, a well should be located up gradient of potential sources of contamination such as septic systems, storage tanks and others (see Chapter 2: *Definitions and Clarifications*, Table 2-2 "contaminant")

Best Management Practice – Exceed Minimum Setback Distance

In some situations it is important to exceed the minimum setback distance specified in the **Wells Regulation.** For example:

- Any time the natural features of the site indicate that contamination could travel easily and quickly to the water source, and
- If the well is going to be:
  - Situated in a shallow aquifer,
  - Set in highly fractured bedrock with thin soil, or
  - Located down gradient from a potential contamination source (remember to consider neighbouring properties)

The **Wells Regulation** does not specify a minimum setback distance between a new well and a property line.

Best Management Practice – Recommended Setback Distances from Property Line

Where practical, it is recommended that at least a minimum (or an increased – see the Best Management Practice above) setback distance be applied from the well to all property lines because it is unlikely a well owner can control what happens on adjacent properties. The appropriate setback distance will be dependant on the type of well (e.g. deep drilled or shallow dug) and geologic conditions encountered.

See "The Requirements – Plainly Stated" on page 4 of this chapter for minimum separation distances.

Best Management Practice – Siting the Well in Complex Geology

Where complex geology exists or contamination is likely to be encountered, it is recommended that a *Professional Engineer* or *Professional Geoscientist* be retained to site the well.

Accessibility and Elevation

The **Wells Regulation** requires the site of a new well to be accessible for cleaning, treatment, repair, testing, inspection and visual examination at all times before, during and after completion of construction of the well and at a higher elevation than the immediate surrounding area.

The person constructing the well is responsible for ensuring that the new well will be accessible at all times, and taking steps identifying all existing and proposed structures and landscaping that may impact the accessibility. A new well is inaccessible when:

- A building (other than a pump house) or driveway is built over the top of the well
- Buildings or structures are constructed around the well preventing equipment, including a drilling rig or excavator, from accessing the well to rehabilitate, deepen or decommission the well
- The ground surface is landscaped in a manner that prevents equipment, including a drilling rig or excavator, from accessing the well to rehabilitate, deepen or decommission the well

Figure 4-2: Well Located Within a Building

This figure shows a well located within a building. The well is not accessible for significant repairs such as replacing the well casing. New wells in a building, such as a residence, are not allowed under the **Wells Regulation**.

Clarification of the term higher Elevation

For the purposes of constructing a new well on a higher elevation, a new well can be constructed on a sloped property.

However, the **Wells Regulation** does not allow a new well to be constructed where the ground surface immediately around the well slopes towards the well.

For example, the well cannot be constructed in a ditch.

Where to Record the Well Location

Once a site for the well has been selected, the location of the well must be carefully noted on the well record, including both the Universal Transverse Mercator (UTM) coordinates using a Global Positioning System (GPS) receiver, and an accurate site sketch.

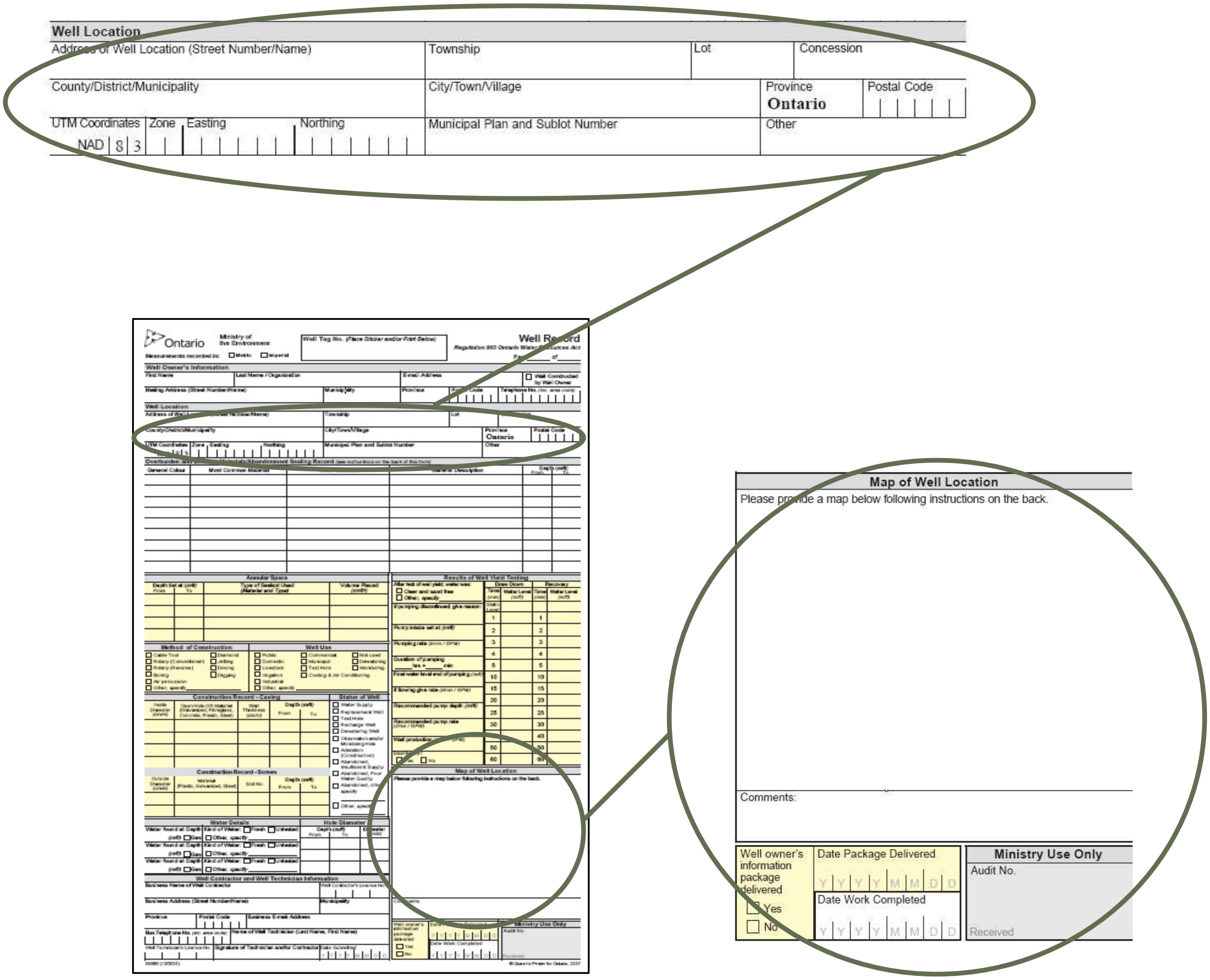
Ontario

The **Wells Regulation** requires that a GPS receiver be used to locate the well with accuracy. The UTM coordinates must be recorded as shown in Figure 4-3.

Frequently, well record location data is inaccurate, which limits the usefulness of the record. Providing the most accurate location information is extremely important because it helps to do the following:

- Identify and locate a well in case of a spill,
- Locate a well when maintenance is needed,
- Ensure the correct well is decommissioned in an area with multiple wells,
- Allow for well inspections when a property is being sold, and
- Determine and interpret local groundwater conditions in a given area.

FIGURE 4-3: WELL RECORD – RECORDING WELL LOCATION



Remember: To allow for the well in the field to be matched with the well record in the Ministry database, it is extremely important that the person constructing the well, fully and accurately completes the well record including all relevant location information. See Chapter 13: *Well Records, Documentation, Reporting & Tagging* for further guidance on filling out the well record.

Tools for Siting the Well

Site Research & Assessment

Table 4-3: Important Information and Actions for Researching and Assessing a Site

What information is Important?	Why is it important?	What actions should be taken?
Size and shape of the property.	• Know the boundaries.	• Look for an Ontario Land Survey or legal property survey (e.g. municipal office.) • Create a site plan or simple map based on observations and client's knowledge.
Position of any features, structures and septic systems or other potential contamination sources on adjacent properties.	• Contaminants in, on, or below ground do not stay in one location but have the potential to migrate.	• Walk around the property . • Talk to the neighbours. • Observe and add to site plan.
Planned property uses as potential sources of contamination.	• Anything the client is planning to do on the site may alter siting plans. Examples include future manure piles, fertilizer mixing areas and pesticide mixing areas.	• Discuss with the client. • Add to site plan.
Distance to and location of any nearby roads, intersections.	• Source of road salt and potential contaminants (e.g. oil spills from containers, fuels).	• Observe • Measure • Add to site plan
Location or planned location of any structures, and their purpose.	• Barns, tractor shed; storage for pesticides, herbicides, and fungicides, inorganic fertilizers, fuel and road salt; repair shops, cattle pens and other structures where potential sources of contaminants will be located.	• Discuss with the client, builder, or construction manager. • Add to site plan.
Landscaping and final grade of site.	• To ensure proper drainage, height of the casing, accessibility and elevation of the well as specified in the **Wells Regulation**.	• Discuss with the client, builder, or construction manager. • Add to site plan.
Location or planned location of septic system, underground fuel storage system; and check status of any existing systems.	• To ensure compliance with separation distances specified in the **Wells Regulation** and Building Code. • Assess potential hazards on site (e.g. leaky or abandoned fuel storage system).	• Discuss with client. • Observe. • Add to site plan.

What information is Important?	Why is it important?	What actions should be taken?
Information about the geology and the overlying soils.	• Aquifer types common to the area will help assess the potential for contaminants to travel. • Understand typical yields and natural water quality and expected well depth.	• See a copy of area formation maps and reports at local municipal, local Conservation Authorities (e.g. source protection planning maps), Ministry of the Environment, Ministry of Northern Development and Mines and Ministry of Natural Resources offices. • Review well records. • Add to site plan.
Topographical features.	• The slope or contours of the land help determine the direction of the groundwater flow.	• Observe the land and note all surface water, hills, valleys, cliffs, caves, etc. • Use topographical maps. • Add to site plan.
Location of previous or existing wells and status.	• Knowledge of existing and abandoned wells will assist in identifying special conditions such as flowing wells, poor water quality, low yield, natural gas, excessive depths, etc. • Unused and improperly abandoned wells may act as pathways for contamination and create hazards.	• Ask the client. • Walk the property. • Review well records. • Properly plug and seal any unused or improperly abandoned wells in accordance with the **Wells Regulation**. • Add to site plan.
Position of wells on adjacent properties.	• The pumping of one well may affect the performance of another. • Drilling of well may cause drill cuttings to impair well water in nearby wells. • Large production wells may have an impact on contaminant movement.	• Talk to the neighbours. • Observe. • Add to site plan. • If possible, seek permission to assess neighbour's well water for background purposes prior to starting to construct a new well.
Planned water uses to assess potential water quantity needs.	• Large municipal taking will require a higher yield than a typical private residential well. • Certain demands will also increase the required yield, such as lawn watering or filling a swimming pool. • Understanding planned water uses allows for the estimation of water needs and minimum water quality.	• Discuss with the client. • Add to site plan.
Location of hydro lines or underground services/utilities.	• May be a threat to personal safety and equipment.	• Check with local utilities such as hydro, gas, cable, water, sewer and telephone (i.e. "Call before you dig") and retain qualified person to locate. • Observe. • Discuss with client. • Add to site plan.

What information is Important?	Why is it important?	What actions should be taken?
Accessibility.	• For well construction equipment access. • For cleaning, treatment, repair, testing, inspection and visual examination as required in the **Wells Regulation.** • For future well maintenance and abandonment (plugging and sealing) as required in the **Wells Regulation**.	• Observe. • Add to site plan.

5. Constructing & Casing the Well

Chapter Table of Contents

Chapter Figures

Chapter Tables

Chapter Description

This chapter covers common well construction methods and materials used in Ontario. This chapter also covers the minimum requirements for the hole, casing and well screen and provides advantages and disadvantages of wells constructed using different equipment and materials. This chapter is structured to parallel the steps involved in the construction of the hole, installation of the casing, creation of the annular space and, where used, installation of the well screen. The filling of the annular space is covered in Chapter 6: *Annular Space & Sealing*.

Regulatory Requirements – Hole & Casing

Relevant Sections – The Wells Regulation

Ontario

Log & Field Notes – Section 12.1

Covering of Well – Section 12.2

Surface Drainage – Section 12.3

Well Depth Requirements – Section 12.4

Well Pits – Subsections 12(7), (7.1), (8) and (9)

Casing – Section 13

Deepening of Wells – Section 13.1

The Requirements – Plainly Stated

Ontario

The Wells Regulation requires the following when a person constructs water well

Log Book and Field Notes

The person constructing the well must have an on site, current and detailed:

- log of overburden and bedrock materials encountered when advancing the hole, and
- field notes regarding the construction of the well

Log Book Exemptions

The person constructing the well is required to keep up-to-date field notes but is not required to have a log of overburden and bedrock materials if the person is constructing the well by the use of a driven point (e.g. direct push technology, jetting).

For further information on log books and field notes requirements and exemptions, see Chapter 13: *Well Records, Documentation, Reporting & Tagging*.

Covering the Well

Whenever the well is left unattended during construction, the person constructing the well must cover the upper open end of the well securely in order to prevent the entry of surface water and other foreign materials.

Surface Drainage

The person constructing the well must ensure that the slope of the ground surface (surface drainage) is such that water will not collect or pond near the well.

Minimum Depth of a New Well

If a new well is being constructed by any method, it must be at least 6 metres (19.7′) deep unless the only useful aquifer is shallower.

In cases where the only useful aquifer is less than 6 metres (19.7 feet) deep, the well must be at least 3 metres (10 feet) deep (For clarification of the term useful aquifer see Chapter 2: *Definitions & Clarifications*, Table 2-2).

Well Casing and Well Screen Construction for a New Well

The casing and well screen must:

- be new materials,
- be clean and free of contamination, and
- not cause contamination of the water with which they are in contact.

The requirement for a casing and well screen to be made of new materials prohibits the re-use of a casing or well screen that was previously installed in a finished well (i.e. where its structural stage has been completed). The requirement for a casing to be made of new materials does not apply to starter (working) casing.

Well Casing for a New Well

The casing must be watertight.

Only continuous sections of casing (e.g. no holes or perforations or slots in the well casing) can be used in the construction of a new well.

The casing must meet the minimum standards as outlined in Table 5-1, page 12.

Well Casing Seams for a New Well

Any seams in the casing must be permanent and watertight.

Well Casing Joints for a New Well

Joints in casing are not allowed unless they:

- achieve a permanent, watertight bond, such as welded steel joints, and
- are made so that the jointed casing does not impair the quality of water with which it comes in contact.

Concrete Well Casing and Casing Joints for New Wells

If the casing is concrete:

- it must be fully cured and commercially manufactured,
- the concrete sections must be properly aligned so that the joints are flush and the casing is centred, and
- the sections must be joined with a mastic sealing material that remains pliable and waterproof and is approved for potable water use by NSF International.

Minimum Length of Well Casing Underground for New Wells

Where a useful aquifer is greater than 6 metres below the original ground surface, the casing must extend at least 6 metres (19.7′) below the original ground surface.

If the only useful aquifer is located between 3 metres (10′) to 6 metres (19.7′) below the ground surface, the casing must extend at least 2.5 metres (8.2′) below the level of the original ground surface.

For clarification of the terms useful aquifer, permanent, watertight and waterproof see Chapter 2: *Definitions & Clarifications*, Table 2-2.

Mounding around the Casing for New Wells

The ground surface must be properly mounded around the well to prevent any collection or ponding of water near the well.

Casing Extent for New Wells in Overburden Aquifers

A new well that obtains water from an overburden formation must be cased:

- From the water intake zone.
- To at least 40 cm (16″) above the highest point on the ground surface within 3 m (10′) radially from the outside of the casing after the land is properly mounded for surface drainage as measured on completion of the well’s structural stage.

Casing Extent for New Wells in Bedrock Aquifers

A new well that obtains water from a bedrock formation, must be cased:

- From the bedrock.
- To at least 40 cm (16″) above the highest point on the ground surface within 3 m (10′) radially from the outside of the casing after the land is properly mounded for surface drainage as measured on completion of the well's structural stage.

Sealing Casing in Bedrock for New Drilled Wells

If the aquifer is located in a weathered bedrock zone, the new drilled well must be cased to the bedrock but the casing is not required to be sealed into the bedrock.

If the aquifer is located in unweathered bedrock,, the casing of a new drilled well must be sealed into the bedrock with suitable sealant to prevent impairment of the quality of the groundwater and the water in the well.

Casing Height Exemption for New Driven Point or Jetted Point Wells

An exemption to the minimum casing height requirement of 40 cm (16″) above the ground surface exists if the new well is made by the use of a jetted point or driven point and meets the following requirements:

- The well must be cased:
  - From highest point on the ground surface within a 3 m (10′) radius of the well's casing after the land is properly mounded for surface drainage as measured on completion of the well's structural stage.
  - To the water producing zone, if the well obtains water from the overburden or to the bedrock if the well obtains water from the bedrock.
- The top of the casing must be a sufficient height above the ground surface to permit the attachment of a well tag.
- A permanent marker must be installed to identify the location of the well and be visible at all times of the year.

For additional information on casing height and surface drainage see Chapter 7*: Completing the Well's Structure*.

For clarification of the terms water intake zone, water producing zone and weathered bedrock see Chapter 2*: Definitions and Clarifications*, Table 2-2.

Casing Height and Mounding for New Wells in New Well Pits

If a new drilled well is constructed with a new well pit, the top of the casing of the new drilled well must be at least 40 cm (16″) above the floor of the well pit.

The new well pit must be cased from the bottom of the well pit to at least 40 cm (16″) above the highest point on the ground surface within 3 m (10′) radially from the outside of the casing as measured upon completion of the well's structural stage.

The ground surface around the new well pit must be properly mounded to prevent ponding near the well.

New well pits are banned for water supply wells in Ontario, with the exception of wells constructed by diamond drilling equipment that are also used in connection with mineral exploration. Requirements for well pit height and other construction considerations are discussed in Chapter 9*: Equipment Installation*

Lightning Rod attachments to Casing for New Wells

A lightning rod is not allowed to be attached, directly or indirectly, to the casing of a new well.

Deepening of an Existing Well:

If the well is deepened all of the casing requirements apply, but the existing casing can continue to be used if it appears sound.

A well is not allowed to be constructed by penetrating through the bottom of a bored or dug well by means of:

- drilling,
- jetting or
- driving.

Information – Encountering Natural Gas

Where a well is constructed and natural gas is encountered, the person constructing the well must immediately notify the well purchaser, the owner of the land on which the well is situated and the Director that the condition exists..

Table 5-1: Minimum Casing Specifications for New Well Construction

Casing Type	Wall Thickness	Inside Diameter	Required Standards
Steel	• Nominal wall thickness of 4.78 mm (0.188″), and • Minimum wall thickness of 4.18 mm (0.16″)	> 50.8 mm (2.00″)	• ASTM A–53 Grade B, • ASTM A589 Grade B, or • ASTM A500 Grade B or C
Steel	• Nominal wall thickness of 2.77 mm (0.11″) and • Minimum wall thickness of 2.41 mm (0.09″)	≤ 50.8mm (2.00″)	• ASTM A–53 Grade B, • ASTM A589 Grade B, or • ASTM A500 Grade B or C
Galvanized (bored and dug wells only)	18 gauge	No minimum diameter	Must be corrugated • ASTM A–53 Grade B, • ASTM A589 Grade B, or • ASTM A500 Grade B or C
Concrete	Nominal thickness of 5.08 cm (2.00″)	≥60.96cm (24.00″)	No standard, but must be fully cured and commercially manufactured
Plastic (PVC or ABS)	Minimum thickness of 0.635 cm (0.25″)	≥10.16 cm (4.00″)	Must be PVC or ABS and approved for potable water use by ASTM or NSF International
Fibreglass	No minimum thickness specified	No minimum diameter	Must be manufactured from virgin resin and virgin fibres and must be approved for potable water use by NSF International
High Yield Wells	Minimum thickness dependent on type of material	Minimum diameter size dependent on type of material	Must follow the casing specifications in Table 2 of AWWA A100–06
Double Walled Casings	Minimum thickness dependent on type of material.	Minimum diameter size dependent on type of material	The outer permanent casing in double walled casing construction must be steel pipe that conforms to ASTM A252 or ASTM A500

See Table 5-7 in this chapter for advantages and disadvantages of different types of well casing.

The **Wells Regulation** <u>does not allow</u> the use of certain materials as well casing for new well construction. Some examples include the following:

- Casing such as large diameter perforated corrugated pipe (culvert) not approved for potable water use,
- Plastic casing that is not approved for potable water use, and
- Hand lain stone, bricks, wood etc.

See the section titled "Improper Casing for New Well Construction" *on* page 54 of this chapter for photographs of unapproved types of well casing material.

Relevant Sections – Additional Regulations or Legislation

Ontario Regulation 213/91 (Construction Projects) as amended made under the *Occupational Health and Safety Act*

RELEVANT STANDARDS

ASTM Standard ASTM A252, 98(2007). "*Standard Specification for Welded and Seamless Steel Pipe Piles.*" ASTM International, West Conshohocken, PA, 2007, DOI: 10.1520/A0252-98R07, www.astm.org.

ASTM Standard A500/A500M, 2007. "*Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes*." ASTM International, West Conshohocken, PA, 2007, DOI: 110.1520/A0500_A0500M-07, www.astm.org.

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ASTM Standard F480, 2006b. "*Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80.*" ASTM International, West Conshohocken, PA, 2006, DOI: 10.1520/F0480-06B, www.astm.org.

ASTM Standard C990M, 2006 (2009). "*Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.*" ASTM International, West Conshohocken, PA, 2009, DOI: 10.1520/C0990-09, www.astm.org.

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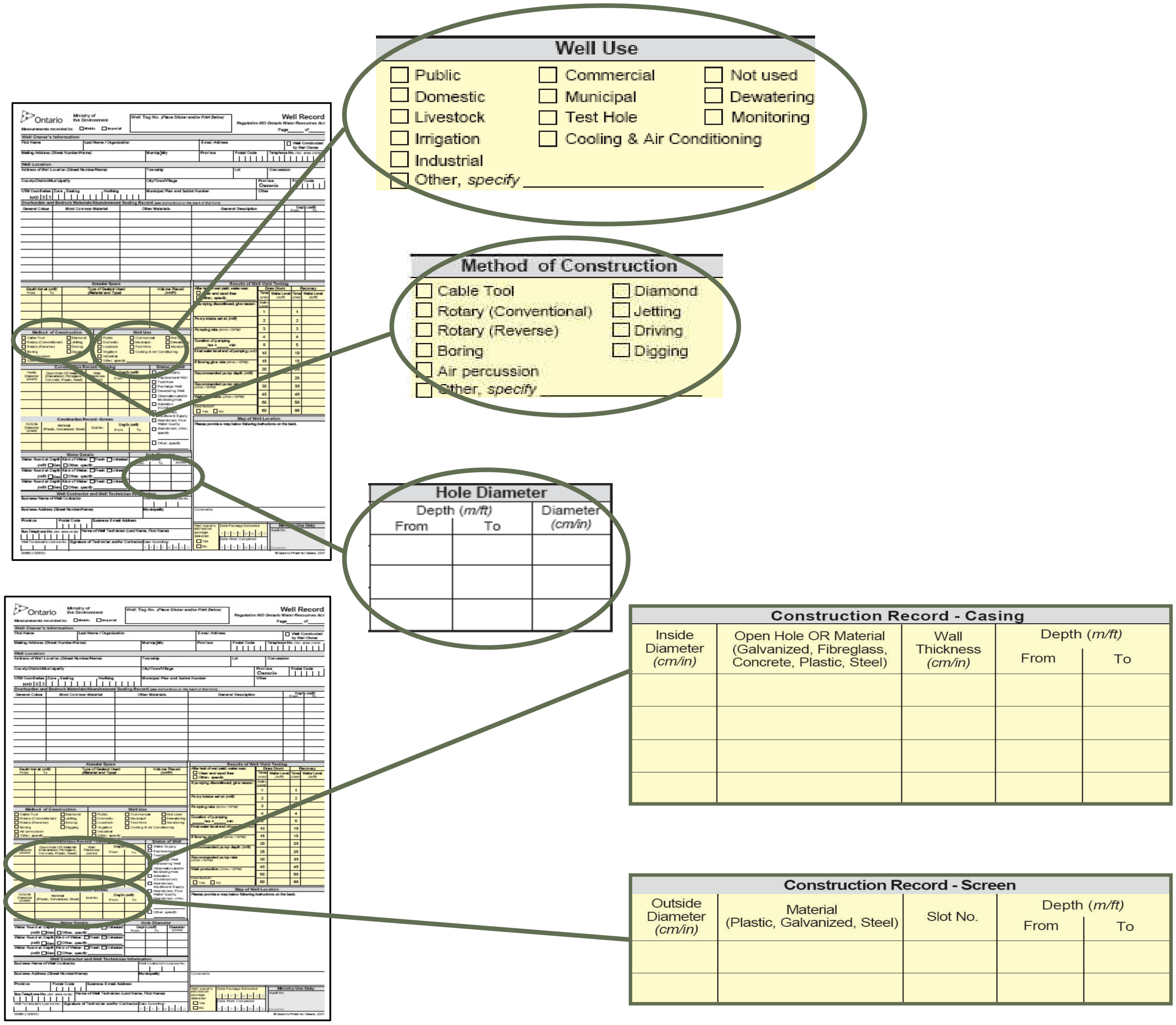
American Water Works Association (AWWA). 2003. ANSI/AWWA C 654-03 "*Disinfection of Wells*." AWWA, Devner, CO. 2003.

American Water Works Association (AWWA). 2006. ANSI/AWWA A100-06 "*Minimum Requirements for Vertical Water Supply Wells*." AWWA, Devner, CO. 2006.

Well Record – Relevant Sections – Hole & Casing

The graphic below shows a sample of the details to be completed on the well record when constructing the hole and installing the casing and well screen in the well.

Figure 5-1: Well Record - Relevant Sections



Best Management Practice – Reporting Concrete Tile Screens

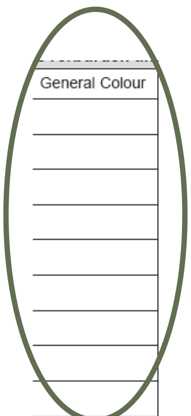
When constructing a well screen with unsealed concrete tiles, the concrete tiles should be recorded in the "Material" section of the "Construction Record – Screen" box of the well record.

FIGURE 5-2: WELL RECORD - RELEVANT SECTIONS (CONTINUED)

Overburden and Bedrock Materials/Abandonment Sealing Record

The back of the well record provides instructions on how to record the details of this section. The example provided is for construction and is recorded in metric units:

General Colours	Most Common Material	Other Materials	General Descriptions	Depth	
				From	To
Brown	Top Soil			0	0.6
Grey	Course Sand	Gravel, Silt	Loose, Wood Fragments	0.6	13.0
Blue	Clay	Silt, Stones	Dense	13.0	25.0
Brown	Fine Sand	Clay		25.0	31.0
Grey	Limestone		Porous, Hard	31.0	34.0



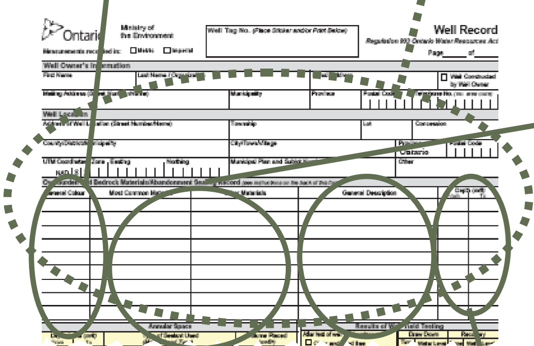
Colour

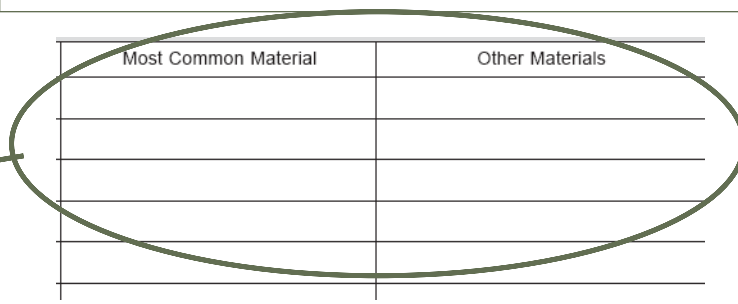
Record the colour of the formation from the list (white, grey, yellow, brown, blue, red, green or black).

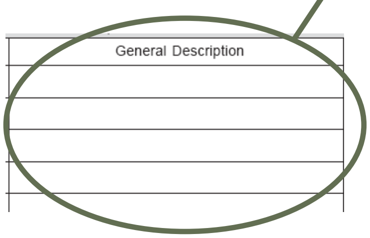
Material

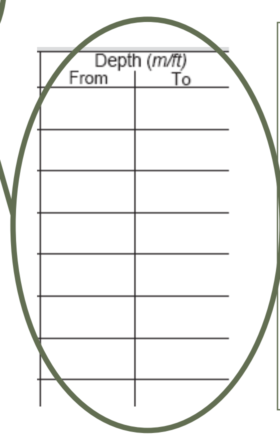
Record the material found in the formation (if more than one material exists, record the primary material in the first column and all others in the second column).

Choose materials from the back of the well record (fill, mulch, peat, clay, silt, gravel, stones, boulders, top soil, fine sand, medium sand, coarse sand, limestone, dolomite, shale, sandstone, slate, quartzite, granite, and greenstone).









Depth

The depth of each formation encountered must be recorded.

All measurements must be recorded in the units indicated at the top of the well record.

All depth measurements are recorded as depth from the ground surface.

For additional information on filling out the well record see Chapter 13: *Well Records, Documentation, Reporting & Tagging.*

Key Concepts

Constructing the Hole

Prior to constructing the hole, the person constructing the well should research and assess the site and surrounding area using the tools outlined in Chapter 4: *Siting the Well,* Table 4-3:*Important Information and Actions for Researching and Assessing a Site*. Proper research and assessment covers the location of aquifers, nature of geological formations, sources of contaminants and well accessibility.

Successful completion of a well depends on the use of equipment and materials that are appropriate for the environment and geological formations at the site. It is important to consider the drill rig or other equipment characteristics including the cutting action as well as any flushing medium (drilling fluid) and its circulation path.

Casing

The **Wells Regulation** defines casing as “pipe, tubing or other material installed in a well to support its sides, but does not include a well screen.”

Casing acts to stabilize the hole, prevents unconsolidated overburden materials from entering the well, accommodates the pumping equipment, and may be used to seal off or isolate unwanted formations.

Making the casing choice that is best for the specific situation involves consideration of the formation, the production capacity of the aquifer, the water uses planned for the well, the size of the hole, and many other factors.

Well Screen

The **Wells Regulation** defines a well screen as perforated pipe or tubing, unsealed concrete tiles or other material installed in a well to filter out particulate matter and form the water intake zone.

To prevent water bearing formation collapse into the well and reduce sediment or particles in the well water, it is important to install a well screen in all unconsolidated formations, in most semi-consolidated formations and sometimes in bedrock.

Common Types of Well Construction

There are four main types of wells constructed in Ontario:

- Drilled
- Bored/Augered
- Dug (by hand or excavating equipment)
- Driven or jetted

Table 5-2, below provides general characteristics, advantages and disadvantages of the common types of wells.

Table 5-2: Common Types of Water Wells[1]

Well Type	Suitable Geologic Materials	Advantages	Disadvantages
Drilled Wells [Commonly 15.9 cm (6″) in diameter, up to 9,000 m (30,000′) deep]	• Overburden and Bedrock	• Drilling systems can reach greater depths than other techniques • Typically yields a consistent rate of groundwater during periods of low recharge • Can penetrate bedrock • Could be less subject to surface and near surface sources of contamination depending on the environment	• Small diameter well provides little storage capacity • May encounter deep groundwater with naturally occurring elevated minerals and gas
Dug Wells [Commonly >1 m (3′) in diameter, up to 10 m (30′) deep]	• Overburden • Sometimes are blasted in bedrock and then area and hole are excavated using digging equipment	• Large diameter well typically provides storage reservoir • Does not require specialized equipment Common backhoe or high hoe using hydraulic shovel can perform the work	• Water shortages can be more common during dry periods because of shallow depths • Susceptible to surface and near surface sources of contaminants • Labour intensive to construct and maintain • Well depth limited by excavating equipment
Bored Wells [Commonly >1 m (3′) in diameter, up to 30 m (100′) deep]	• Overburden	• Large diameter well typically provides storage reservoir	• Water shortages can be more common during dry periods because of shallow depths • Susceptible to surface and near surface sources of contaminants • Well depth limited by caving conditions
Driven-point or Jetted Driven Point wells [Commonly > 5 cm in diameter]	• Overburden	• Can be done with hand held or small inexpensive drilling machines • Wells can be connected together to increase yield	• Water shortages can be more common during dry periods because of shallow depths • Susceptible to surface and near surface sources of contaminants • Small diameter well provides little storage capacity

[1] Modified from: McKenna, F. P, and Ontario Ministry of the Environment. 1987. *Water Wells and Ground Water Supplies in Ontario*. Queens Printer Press for Ontario. Table 2, page 16.

Constructing the Hole

The following sections provide the key considerations when constructing the hole. Figures 5-22 to 5-29 in the "Diagrams for Common Well Types" section at the end of this chapter further illustrate well construction considerations.

It is very difficult to correct mistakes after the fact. It is important, therefore, to utilize and execute best management practices throughout the well construction process.

Choosing a Construction Method

The construction method:

- should allow the person constructing the well to get representative samples to identify the boundaries of permeable zones,
- must allow for the proper recording of formations including aquifers encountered during construction,
- must not contaminate the groundwater and the environment,
- must meet the minimum depth and diameter requirements of the **Wells Regulation** (see Table 5-5 and Figures 5-22 to 5-29 for minimum diameters), and
- should be able to penetrate the geological formation.

Table 5-3 provides methods, characteristics, advantages and disadvantages of various well construction systems in particular formations.

If groundwater is anticipated to discharge or is discharging from a well during construction at a rate of more than 50,000 litres per day (about 11,000 Imperial gallons per day), a Permit To Take Water under the *Ontario Water Resources Act* must be obtained. More information on Permit To Take Water approvals can be found at the following website: http://www.ene.gov.on.ca/envision/water/pttw.htm.

The person constructing the well should ensure that the location of groundwater, drill cuttings and other materials discharging from the well do not cause environmental impacts such as erosion, impairment of surface water courses and off-site flooding. This may require the use of settling pits on the property. A sewage works certificate of approval under the *Ontario Water Resources Act* may be required if the person constructing the well discharges the water, drill cuttings or other material and the discharge capacity exceeds 10,000 litres per day. A guide to explain the sewage works process can be found at the following website: http://www.ene.gov.on.ca/envision/gp/4980e.htm.

Table 5-3: Common Water Supply Well Construction Systems, Cutting Actions Characteristics, and their Advantages and Disadvantages[2 and 3]

System	Characteristics	Advantages	Disadvantages
Conventional Rotary Drilling **Water or Mud**	• Hole Diameter: 7-120 cm (3-24″) • Depth: 0-9000 m (0-30,000′) • Cutting action and bit consist of rotary crush/tri or bi cone • Continuous rotation of the drill stem (rod) with the bit or cone breaks the formation • Rotation speeds of the drill cone or bit vary from 15 to 750 rotations per minute • Drilling fluids are forced down the inside of the drill stem • Drill cuttings are removed by either water or mud drilling fluid • Rig: Table or top drive mud pump • Can drill in overburden and bedrock	• Penetration rates high • Minimal casing required to keep hole open during operation • Quick set up with rig • Well screens can be set easily as part of casing string • Hole can be readily gravel packed and grouted • Can drill a deep hole fairly quickly in overburden and bedrock	• Difficult to drill in boulders or cobbles • Rigs costly, high maintenance • Rig mobility limited to solid ground conditions • Not good in cold conditions • Drilling fluid management requires special skill • Drilling fluids (water or mud) can be lost or difficult to maintain in fractured bedrock • Drilling fluids can clog the formation • Completed well may be difficult to develop because of mud or filter-cake on wall of hole • Location of water bearing zones may be difficult to detect • Difficult to collect accurate samples to determine screen slot size

[2] Modified from: US Army Corp of Engineers. November 1, 1998. *Monitoring Well Design at Hazardous, Toxic, and Radioactive Waste Sites* (EM 1110-1-4000) Table 3-1,page 3-3.
[3] Modified from: Fleming College. 2008. Manual for Continuing Education Course *Monitoring Wells – Construction (for Ontario Well Technicians)*: *Table 6, p. 64.*

System	Characteristics	Advantages	Disadvantages
Conventional Rotary Drilling **Air**	• Hole Diameter: 7-75 cm (3″-30″) • Depth: 0-1,500 m (0-5,000′) • Cutting action and bit consist of rotary crush/cone and rotary cut/drag bit • Air, instead of a drilling fluid, is forced down the inside of drill stem • Can drill in shallow overburden and bedrock but more commonly used in fractured bedrock environments	• Quick cutting removal • Good in cold weather • Penetration rates high • Drilling mud or water not required • Aquifer clean of flushing media • Easier to identify the formation materials • Easier to develop the well • Bit life extended • Can estimate yield during drilling	• Difficult to use in overburden environments • Rigs costly, high maintenance • Rig mobility limited to solid ground conditions • Air, cuttings and groundwater blown from hole can be a hazard to crew and environment • Casing required to keep hole open in the overburden and broken bedrock
Reverse Circulation Rotary	• Hole Diameter: 60-125 cm (24″-50″) • Depth: 0-1,500 m (0-5,000′) • Cutting action and bit consist of rotary crush/tri or bi cone or rotary cut/drag bit • Drilling fluids are circulated down the hole outside of the drilling rods and pumped up through the inside of the drill bit and drill stem • Water is typically used as the drilling fluid • Rig: reverse circulation • Can drill in overburden and bedrock	• Similar advantages as Conventional Rotary Drilling with water or mud • Less drilling fluid additive is required to lift cuttings during drilling • Quick development time • Larger diameter holes can be drilled • Drilling fluid loss is minimal because drilling fluid is being pushed at a low velocity • Works well in many overburden and sedimentary bedrock formations	• Similar disadvantages as Conventional Rotary Drilling with water or mud • A large amount of water is needed to keep the hole open during drilling • Rigs costly, high maintenance • Extra costs for additional drill pipe being installed for deep wells • Rig mobility limited to solid ground conditions • Not good in cold conditions • Drilling fluid management requires special skill • Not suitable for metamorphic or igneous bedrock formations

System	Characteristics	Advantages	Disadvantages
Dual Wall Reverse Circulation Rotary	• Hole Diameter: 9-25 cm • (3.5″-10″) • Depth: 0-610 m (0-2,000′) • Cutting action and bit consist of rotary crush or rotary percussion • Similar to reverse circulation rotary except an additional outer drill pipe is used • Fluids or air are circulated down between the inner and outer pipes and pumped up through the inside of the drill bit and drill stem • Can drill in overburden and bedrock	• Similar advantages as Conventional Rotary Drilling with water or mud or air depending on the application • Reduces lost circulation of drilling fluids	• Similar disadvantages as Conventional Rotary Drilling with water or mud or air depending on the application except for the loss of circulation of drilling fluids • Limited diameter and depth • Needs well trained crew
Dual Rotary/ Casing Advancement	• Hole Diameter: 7-120 cm (3-24″) • Cutting action and bit consist of rotary cut, rotary crush or rotary percussion • Casing string is rotated using a casing rotator and pulled downhole just behind drill string and bit or in some cases ahead of the bit • Drilling bit typically has an underreamer, which allows the bit to swing out below the casing and retract into the casing when drilling is complete • Drilling fluids circulated similar to Conventional Rotary systems • Typically used in overburden and broken (weathered) bedrock	• Similar advantages as Conventional Rotary Drilling with water or mud or air depending on the application except good for most overburden environments • Reduces lost circulation of drilling fluids • Able to determine water flow at any time	• Similar disadvantages as Conventional Rotary Drilling with water or mud or air depending on the application except for the loss of circulation of drilling fluids • More expensive • Requires larger set up area and support equipment

System	Characteristics	Advantages	Disadvantages
Down-the-Hole Hammer (Air Percussion Rotary)	• Diameter: 10-90 cm (4″ - 36″) • Depth: 0-610 m (0 - 2,000′) • Cutting action and bit consist of rotary percussion or button bit • The repeated motion (similar to a jack hammer) crushes the material at the bottom of the hole • Commonly used in bedrock	• Quick cutting removal • Aquifer clean of flushing media • Easier to identify the formation materials • Good in cold weather • Penetration rates high • Well development relatively easy	• Rigs costly • Limited to bedrock • Rigs heavy, limiting accessibility • May require lubrication of the bit during drilling • Can cause fracturing of hole
Cored Hole / Diamond Drilling	• Hole Diameter: 6-11 cm (2.5″ – 4.5″) • Depth: 0-3,050m+ (0 – 10,000′+) • Cutting action and bit consist of rotary abrasive • Similar to Conventional Rotary Systems	• Portable • Will not fracture rock • Can use air as flushing medium • Can drill holes at angle	• Slower than other rotary drilling methods • Cost per metre (foot) may be higher than other drilling methods • When using water as the drilling fluid (medium), a large volume of water is needed

System	Characteristics	Advantages	Disadvantages
Cable Tool	• Hole Diameter: 10-120 cm (4″ - 48″) • Depth: 0-1,500 m (0-5,000′) • Cutting action and bit consist of percussion, chisel bit or button bit • Repeated dropping of a heavy string of drill tools and a bit crushes material at the bottom of the hole • During drilling in overburden, casing is driven to keep the hole open • The cuttings are removed by a bailer. • Commonly used for shallow overburden formations from 0-45 m (0-150′) • Commonly used in shallow limestone bedrock and other soft bedrock from 0-30 m (0-100′)	• Can be used in bedrock and overburden • Can drill through boulders and highly cavernous or fractured rock • Rigs inexpensive, easy maintenance • Low energy needs • Good in cold weather • Hole stabilized during drilling using casing • Excellent method when lost circulation of drilling fluid is a problem • Excellent method for development of well • Typically a very good method to detect low yielding groundwater bearing zones	• Penetration rates slow • May be difficult to pull long strings of casing with a rig that does not have special equipment • Heavier wall, larger diameter casing than most other methods • Heavy steel drive pipe can limit accessibility • Temporary casing can impact placement of filter pack and sealant (grout) • Heaving of sediment into bottom of casing can be a problem
Bucket Auger	• Diameter: 60-120 cm (24″-48″) • Depth: 0-40 m (0-130′) • Cutting action and bit consist of rotary cut • Used in overburden only	• Fast method for constructing large diameter wells	• Limited to about 30 m (100′) in depth • May be limited to formations that will not collapse • Cannot penetrate bedrock formations • Generates a large volume of soil to be removed

System	Characteristics	Advantages	Disadvantages
Excavator	• Diameter: 1-10m (3-30′) • Depth: 0-10m (0-30′) • Removal of material with hydraulic shovel • Used in overburden • Sometimes a space in the bedrock is blasted breaking the consolidated rock. The broken rock in the blasted area is excavated using digging equipment	• Fast method of constructing large diameter wells	• Limited to about 10 metres (30′) in depth • Cannot penetrate bedrock formations unless the designated space in the bedrock is blasted • Generates a large volume of soil to be removed • Creates an extremely large annular space that will required to be properly sealed
Jetting	• Diameter: 5-10 cm (2.5 - 4″) • Depth: 0-10m (0-30′) • Removal of material by washing action of high pressured water • Casing and driven point (drive point) advance as the material is removed • Used in overburden only	• Fast method of constructing small diameter wells • Relatively inexpensive method	• Limited to about 10 m (30′) in depth • Cannot penetrate bedrock formations • Subject to caving where the casing is not installed at the time of jetting • Jetting action may create a significant annular space requiring proper sealing
Driving	• Diameter: 5-10 cm (2.5 - 4 ″) • Depth: 0-10m (0-30′) • Casing and driven point (drive point) are pushed into the ground using a tool bar or hammer • Used in overburden only	• Fast method of constructing small diameter wells • Relatively inexpensive method	• Limited to about 10 m (30′) in depth • Cannot penetrate bedrock formations • The use of couplings to join casing lengths could create a small annular space that will be difficult to seal

Table 5-4: Formations and Some Appropriate Construction Equipment[4]

Table 5-4 does not provide for all construction methods such as sonic or direct push technologies

For flowing sand conditions use the same recommendations as outlined for "Quicksand & flowing sand" formation in Table 5-4

<table>
<tr><th>Type of Formation</th><th>Cable Tool</th><th>Direct Rotary (with fluids)</th><th>Direct Rotary (with air)</th><th>Down-the-hole-hammer</th><th>Drill-through-casing hammer</th><th>Reverse Rotary (with fluids)</th><th>Reverse Rotary (dual wall)</th><th>Hydraulic Percussion</th><th>Jetting</th><th>Driven**</th><th>Auger</th><th>Digging</th></tr>
<tr><td>Dune Sand</td><td>2</td><td>5</td><td rowspan="9">Not recommended</td><td rowspan="11">Not recommended</td><td>6</td><td>5*</td><td>6</td><td>5</td><td>5</td><td>3</td><td>1</td><td>5</td></tr>
<tr><td>Loose sand and gravel</td><td>2</td><td>5</td><td>6</td><td>5*</td><td>6</td><td>5</td><td>5</td><td>3</td><td>1</td><td>4</td></tr>
<tr><td>Quicksand & flowing sand</td><td>2</td><td>5</td><td>6</td><td>5*</td><td>6</td><td>5</td><td>5</td><td rowspan="19">Not applicable</td><td>1</td><td>***</td></tr>
<tr><td>Loose boulders in alluvial fans or glacial drift</td><td>3-2</td><td>2-1</td><td>5</td><td>2-1</td><td>4</td><td>1</td><td>1</td><td>1</td><td>2</td></tr>
<tr><td>Clay and silt</td><td>3</td><td>5</td><td>5</td><td>5</td><td>5</td><td>3</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>Firm shale</td><td>5</td><td>5</td><td>5</td><td>5</td><td>5</td><td>3</td><td rowspan="16">Not applicable</td><td rowspan="16">Not applicable</td><td rowspan="16">Not applicable</td></tr>
<tr><td>Sticky shale</td><td>3</td><td>5</td><td>5</td><td>3</td><td>5</td><td>3</td></tr>
<tr><td>Brittle shale</td><td>5</td><td>5</td><td>5</td><td>5</td><td>5</td><td>3</td></tr>
<tr><td>Sandstone – poorly cemented</td><td>3</td><td>4</td><td rowspan="13">Not applicable</td><td>4</td><td>5</td><td>4</td></tr>
<tr><td>Sandstone – well cemented</td><td>3</td><td>3</td><td>5</td><td>3</td><td>5</td><td>3</td></tr>
<tr><td>Chert nodules</td><td>5</td><td>3</td><td>3</td><td>3</td><td>3</td><td>5</td></tr>
<tr><td>Limestone</td><td>5</td><td>5</td><td>5</td><td>6</td><td>5</td><td>5</td><td>5</td></tr>
<tr><td>Limestone with chert nodules</td><td>5</td><td>3</td><td>5</td><td>6</td><td>3</td><td>3</td><td>5</td></tr>
<tr><td>Limestone with small cracks or fractures</td><td>5</td><td>3</td><td>5</td><td>6</td><td>2</td><td>5</td><td>5</td></tr>
<tr><td>Limestone – cavernous</td><td>5</td><td>3-1</td><td>2</td><td>5</td><td>1</td><td>5</td><td>1</td></tr>
<tr><td>Dolomite</td><td>5</td><td>5</td><td>5</td><td>6</td><td>5</td><td>5</td><td>5</td></tr>
<tr><td>Basalts – thin layers in sedimentary rock</td><td>5</td><td>3</td><td>5</td><td>6</td><td>3</td><td>5</td><td>5</td></tr>
<tr><td>Basalts – thick layers</td><td>3</td><td>3</td><td>4</td><td>5</td><td>3</td><td>4</td><td>3</td></tr>
<tr><td>Basalts – highly fractured (lost circulation zones)</td><td>3</td><td>1</td><td>3</td><td>3</td><td>1</td><td>4</td><td>1</td></tr>
<tr><td>Metamorphic rocks</td><td>3</td><td>3</td><td>4</td><td>5</td><td>3</td><td>4</td><td>3</td></tr>
<tr><td>Granite</td><td>3</td><td>3</td><td>5</td><td>5</td><td>3</td><td>4</td><td>3</td></tr>
</table>

* Assuming sufficient hydrostatic pressure is available to contain active sand (under high confining pressures). Rate of Penetration: 1 – Impossible 2 – Difficult 3 – Slow 4 – Medium 5 – Rapid 6 – Very Rapid

** Driven means manual and mechanical assisted methods (hand held, electric or pneumatic rotary hammers).

*** Digging in quicksand and flowing sand is not recommended because the hole is not cases as it is advanced and the formation will likely slough.

[4] Modified from: Sterrett, Robert J. 2007. *Groundwater and Wells: Third Edition.* Johnson Screens/a Weatherford Company. New Brighton, Minnesota. Table 7.3, p. 283.

Flushing Methods

Drilling fluids (flushing media) are an important consideration when choosing a construction method. During certain well construction, drilling fluids will help to do the following:

- Lubricate the drill bit, string and bearings to prevent breakdowns,
- Clean and cool the bit to allow for continued long periods of drilling without having to replace the bit,
- Stabilize the hole by exerting enough pressure to prevent caving,
- Seal the hole wall to reduce fluid loss to the formation, and
- Lift well cuttings from the bottom of the hole to the surface to allow drilling to continue into the formation.

There are three main flushing methods:

- Fluid based [e.g. water, water and bentonite (clay additives), water and polymeric additives, and water, bentonite (clay additives), and polymeric additives]
- Air based (e.g. dry air, air and water mist, air with a film of water containing a foam, and air, foam and film strengthening materials such as polymers and bentonite)
- Dry or mechanical based (uses a mechanical action)

For additional information on flushing media (drilling fluids) see the following:

- Table 7: Advantages and Disadvantages of Flushing Methods for Drilling Monitoring Wells, from the Fleming College Continuing Education Course Manual: *Monitoring Wells – Construction (for Ontario Well Technicians).*
- *Practical Handbook of Environmental Site Characterization and Ground-Water Monitoring, Second Edition*, by David, M. Nielsen (editor), CRC/Taylor and Francis, Boca Raton, FL. 2005.
- Chapter 8: Drilling Fluids, from *Groundwater and Wells, Third Edition*. Johnson Screens/ a Weatherford Company. New Brighton, Minnesota.

Location of the Aquifer – Shallow or Deep

A shallow aquifer may make it more feasible to use a backhoe or a boring rig to construct a large diameter well. Aquifers located in bedrock formations require specialized equipment designed to deal with these formations.

The **Wells Regulation** requires that new wells be a minimum 6 m (19.7′) in depth unless the only useful aquifer (i.e. a water–bearing formation that is capable of transmitting water in sufficient quantities to serve as a source of a water supply) necessitates a shallower well. In no case is the well allowed to be less than 3.0 m (10′) deep.

As indicated in Chapter 4: *Siting the Well,* Table 4-3: Important Information and Actions for Researching and Assessing a Site, well purchasers with the assistance of their licensed well contractors or environmental consultants can assess and review groundwater reports and well records near the area of the proposed well to determine potential groundwater locations.

See Chapter 2: *Definitions & Clarifications*, Table 2-2 for clarification of the term “useful aquifer”.

Accessibility or Space to Work on the Well Site

Site access or space to work at the site may be a consideration in some situations. Overhead or underground utilities or obstructions may not allow certain equipment (e.g. a drilling rig) to be admitted. Small working space or long distances from roadways may also limit equipment access to the well site. Separation distances from sources of contaminants must also be considered.

See Chapter 4: *Siting the Well* for further information on accessibility or space to work at the well site.

Purpose of the Well

There are many reasons to construct a well. The purpose of the well may also dictate what type of equipment is required to construct the well. For example, a specialized rotary drilling rig may need to be used to construct a deep large diameter municipal well.

Reasons for constructing a well include the following:

- Domestic water supply
- Livestock watering
- Irrigation
- Industrial
- Commercial
- Municipal or communal water supply
- Public supply
- Cooling, air conditioning or heating (geothermal well)
- Dewatering
- Testing and monitoring
- Recharge (where well is located into groundwater or an aquifer)

Size of the Hole

The hole must be constructed to ensure there is a minimum annular space created between the well casing and the side of the well, and in some cases between the well screen and the side of the well. Annular spaces need to be large enough to ensure suitable sealant (grout) can fill and adhere around the entire outer well casing to prevent surface water, groundwater, natural gas and other foreign materials from migrating along the outside of the well casing.

Table 5-5, below, and Table 6-1 in Chapter 6: *Annular Space & Sealing* provide the minimum diameter and depth of the hole relative to the outer diameter of the permanent casing (or casings) required to create the minimum width and the minimum depth of the annular space required by the **Wells Regulation**.

Table 5-5: Minimum Hole and Annular Space Requirements

<table>
<tr><th></th><th>Bored well (concrete casing) ≥ 6 m deep</th><th>Bored well (concrete casing) 3-6m deep</th><th>Dug (or Excavated), Jetted or Driven-point Well</th><th>Drilled well or any other well ≥6 m deep that is not listed on this table</th><th>Drilled well or any other well 3-6m deep that is not listed on this table</th></tr>
<tr><td>Minimum Depth of Annular Space below Ground Surface</td><td>≥6 m (19.7′)</td><td>Bottom of well</td><td>None</td><td>≥6 m (19.7′)</td><td>Bottom of well</td></tr>
<tr><td rowspan="3">Minimum Diameter of Hole Greater Than Outer Casing Diameter to Create Annular Space</td><td colspan="2">Ground surface to ≥2.5 m (8.2′) below land surface
≥15.2 cm (6″)</td><td rowspan="3">None</td><td colspan="2">≥7.6 cm (3″)</td></tr>
<tr><td colspan="2" rowspan="2">>2.5 m (8.2′) below the ground surface
≥7.6 cm (3″)</td><td colspan="2">If centralizers attached to casing >6 m below the ground surface using rotary drilling equipment:
≥5.1 cm (2″)</td></tr>
<tr><td colspan="2">If breakaway guide is attached 2 m above the bottom of any casing using cable tool equipment:
≥5.1 cm (2″)</td></tr>
</table>

Best Management Practice – Size of Hole

It is important to create hole diameters of sufficient width to ensure suitable sealant will fill and adhere to the well's casing and formation. In most subsurface conditions, it is important for the well diameter to be at least 10 cm to 20 cm (4″ to 8″) larger than the outer diameter of the casing. The larger size of hole facilitates the proper placement of the suitable sealant and filling materials in the annular space using a tremie pipe.

Care should be taken in determining the size of the hole. Ensure the hole is able to accommodate a casing of sufficient size to allow for the installation of necessary downhole equipment (e.g. pumps).

Where the approved casing is not cylindrical, the same minimum hole diameter and annular space requirements found in Table 5-5 apply.

Constructing Straight and Plumb Holes

No single drilling construction method is best for every type of drilled well or every geologic condition. Each situation may call for a change in the cutting action, flushing media and equipment, as the construction progresses.

A crucial part of constructing a good hole is ensuring that the hole is straight and plumb to minimize problems with placing the casing, sealing the annular space and installing pumping equipment.

Causes of a Crooked Hole

Some of the more common reasons that a hole is not straight include the following:

1. Excessive pull down on drill string.
2. Drilling aggressively through changing hard and soft formations.
3. Deflecting off boulders.
4. Collaring hole on sloping bedrock surface.

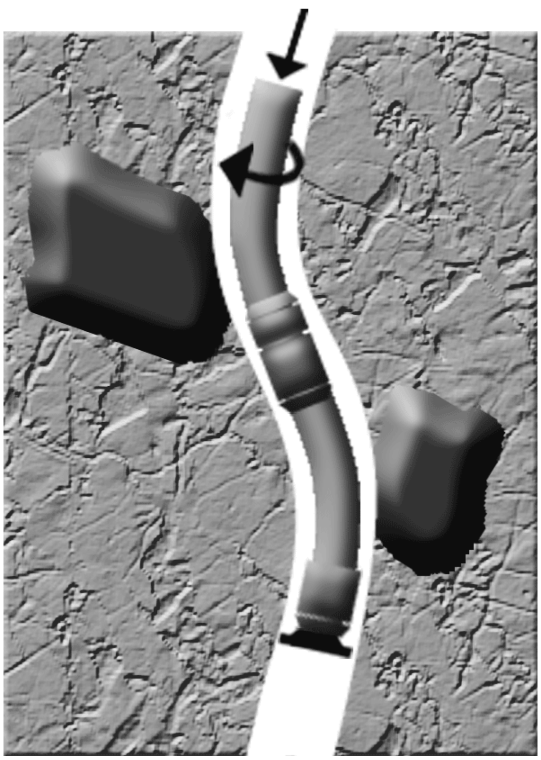


Figure 5-3: A Crooked Hole as a Result of Drilling Tools Deflecting off Boulders[5]

[5] Fleming College. 2008. Course Manual for *Well Constructed: Training for Assistant Well Technicians in Ontario*. Chapter 7, Figure 7-7.

During construction, a common practice is to use a mirror to reflect sunlight down the hole to permit a visual check on the straightness of the hole. A mirror observation method can be used to check for straightness if a plumb–bob is lowered down the hole. A mirror can be used above the water level or when the well is dry to check the following:

- Straightness of the hole
- Water levels
- Water entry points in cascading conditions or during pumping
- Condition of the hole or casing
- Occurrence of obstructions in hole such as boulders
- Occurrence of leakage of water and unconsolidated material at bedrock – casing interface

Other indicators of a crooked hole in a drilled well include:

- Rotary drilling – It is important to watch the drill string when drilling and tripping in/out to see if the drill string stays in the centre of the casing in the collar area. If the drill string does not stay in the centre of the casing, the hole is not plumb and straight. If using this method, ensure that:
  A) The rig is set up stable and level, and
  B) A new or well maintained drill string is used to minimize the degree of deviation within the string.
- Cable tool drilling – As a simple indicator, it is important to look at the relationship of the drill cable to the top of the casing. If the cable is always centred in the casing, then the hole is plumb and straight. If the cable is not always centred, then the hole is not plumb and straight.

Best Management Practice – Use Stabilizers and Good Construction Techniques

To help minimize the occurrence of crooked or out of plumb holes, it is important to use good construction techniques in combination with stabilizers on the drilling tools and inclinometers to measure the angle of the holes.

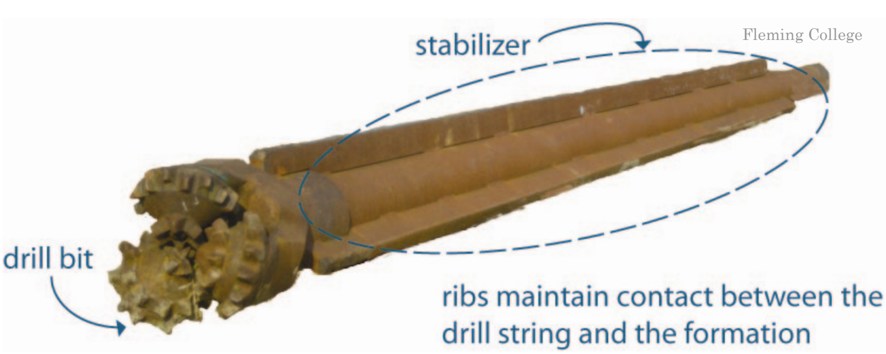


FIGURE 5-4: A DRILL BIT STABILIZER

Figure 5-4 shows a drill bit stabilizer. The circled portion shows the stabilizer has three ribs attached to the rod. The use of a stabilizer such as the one shown here, will help keep the hole straight by maintaining wall contact over a long distance.

Creation of Unintended Cavities, Voids and Spaces Outside of the Hole Area

Several factors can contribute to the creation of a cavity, void or space during well construction:

- Cutting action
- Drilling system
- Flushing medium
- Local geology
- Casing accessories such as drive shoes, casing welds, weld rings and couplings
- Drill cuttings being pushed out of the hole

Best Management Practice – Reducing the Risk of Creating Spaces and Voids

To reduce the risk of unintended small voids and spaces that may be difficult to seal, it is important to do the following:

- Not use an oversized drive shoe with a larger outside diameter than the casing, (see Table 5-9).
- Minimize the thickness of multiple pass welds, (see Table 5-9).
- Avoid using weld rings as they can create a larger annular space (see Table 5-9) and instead, use a thicker walled casing [e.g. 6.4 mm (0.250″) – see Table 5-9] to increase the surface area at the ends of the casing to be welded. As an alternative, corner cut the casing ends at a 45 degree angle (beveled). The thicker casing provides a stronger welded joint without causing a larger annular space (see Table 5-9).
- Minimize the use of band and coupled casing. Use welded casing sections instead.
- Use minimum volumes of air or water based flushing media with good drilling practices to minimize hole erosion and to avoid losing circulation.

If any voids are created on the outside of the casing as a result of the drilling activity, the voids must be filled with suitable sealant or filling material as described in Chapter 6: *Annular Space & Sealing*.

Covering the Hole

An open hole or excavation is not only a safety hazard for children, farm animals and other living things it is also an open and direct pathway into the aquifer or other subsurface formation. An open well can allow contaminants from spills near the well to wash into the open hole and impair the aquifer.

Ontario

The **Wells Regulation** requires that whenever a well under construction is left unattended, including during a minor alteration or the installation of a pump, the person constructing the well must cover the upper open end of the well securely in a manner sufficient to prevent entry of surface water and other foreign materials into the well. The person constructing the well must also ensure that the surface drainage is such that water will not collect or pond in the vicinity of the well.

Temporary covers need to prevent surface water or other foreign materials from entering the well and be secure enough to prevent physical hazards and vandalism. Covering a well may include installing a lockable watertight well cap on top of the well and sealing the cover to the well casing. In cases where there is no casing in the hole, a temporary vertical tube and horizontal cover that is larger than the hole may need to be driven into the ground and around the well. Persons constructing wells must also use covers that meet the requirements of Ontario's Construction Projects regulation (Ontario Regulation 213/91[6] made under the *Occupational Health and Safety Act*) to prevent physical accidents at the well site for the public and workers. The person constructing the well must also take other reasonable steps to secure the site. As such, leaving the drill rods and other tools in the hole, a piece of plywood lying on top of the well or putting a rag inside the well is not considered a proper well cover.

Recording Geological Information

Ontario

The **Wells Regulation** requires that the person constructing the well make a log of the overburden and bedrock materials (geological formations) and keep up-to-date field notes at the well site.

Wells that are constructed by use of a driven point are exempt from the requirement to make and keep a log of overburden and bedrock materials but field notes are required to be made, kept up to date, and available at the well site.

Geological materials encountered during well construction could include the following:

- **Overburden formations** – such as clay, silt, sand, gravel, or stones (see Table 5-6 for additional information on overburden materials)
- **Bedrock formations** – such as sandstone, limestone, granite, or other bedrock

See Chapter 2: *Definitions & Clarifications*, Table 2-1 for definitions of overburden and bedrock.

[6] *Occupational Health and Safety Act*, R.S.O. 1990, Chapter 0.1, Ontario Regulation 213/91: Construction Projects

Table 5-6: Particle Sizes for Overburden Materials[7]

Major Divisions	Sub-Divisions	Field Identification	Other Properties
Coarse-grained Soils/Sediments	Gravel	• Smaller than 75 mm (3″) but larger than 6 mm (¼″)	• Easiest to distinguish due to familiarity • Most important property to watch for is grade (well or poor)
	Sand	• Smaller than 6 mm (¼″) but large enough to be visible to the naked eye	
Fine-grained Soils/Sediments	Silt	• Powders easily when dry • Gritty to the teeth • Dries rapidly • No shine when moist and stroked with a knife blade • Particles are between .002 mm and .08 mm in size (approx. 1/10000 of an inch)	• Consist of particles of fresh-ground rock which have not had time to change their character into the minerals which make up clays • Can be easily recognized when water is present as it almost always is where silt occurs
	Clay	• Sticks to fingers when moist and does not wash off readily • Not gritty to the teeth • When moist, shiny surface is exposed when stroked with a knife blade • Particles are smaller than 0.002 mm (1/10000 of an inch)	• Soils which are made up of the finest particles • Contain “clay minerals” which result from changes in the bedrock material through weathering • Combination of clay minerals, their size and structure, with water gives clay its special properties
Soil/Sediment Mixture	Glacial Till	• Extreme range of grain sizes from large boulders to the finest clays • Usually very hard and compact soil containing boulder, gravel, sand, silt and clay sized particles • Results from the movement of glaciers over solid rock without any sorting of the material	• Sometimes referred to as hardpan – but this term should not be used • If dried and placed in a glass of water, it will likely disintegrate almost immediately showing how deceptive its apparent strength can be
Other	Fill	• Identified by the presence of small pieces of glass, brick, concrete, wire, twigs, grass or foreign material	• Special care must be taken in all studies of soil to guard against mistaking fill for natural soil • In many city areas, depressions have been filled up with rubbish and soil excavated from other areas.
	Cobbles	• 75 mm to 200 mm (3″ to 8″) in size	• Can be encountered in poorly graded tills and other glacial deposits
	Boulders	• 200 mm (8″) and above in size	

This is one of several grain-size scales used. A grain-size scale widely used and accepted by geologists, the Udden-Wentworth grain-size scale, is described in *Sedimentary Rocks in the Field*[8] It divides sediments into seven grades: clay, silt, sand, granules, pebbles, cobbles and boulders and subdivides sands into five classes and silts into four.

[7] Fleming College. 2008. Course Manual for *Well Constructed: Training for Assistant Well Technicians in Ontario*. Chapter 3, Table 3-9.
[8] Tucker, Maurice, E. 2003. *Sedimentary Rocks in the Field*. John Wiley and Sons Ltd. ISBN: 0-470-85123-6. Page 69, Table 4.2.

The person constructing the well should collect representative samples at measured depths and at intervals that will show the complete geological character of the hole. For example, formation samples could be collected at 1.5 metre (5′) intervals and at every change in formation materials. The field notes should document the:

- changes in formation materials including the top and bottom of each material/unit encountered,
- observed characteristics of each formation unit,
- depth to groundwater, water quality and gas observations,
- materials and equipment used at the site and in the well, and
- location information.

See Chapter 13: *Well Record, Documentation, Reporting & Tagging* for further information on log books and field notes and for an example of a log book entry sheet.

Encountering Contamination and Water Quality Problems

It is often unknown when gas or other types of contamination will be encountered during well construction. There are many areas within Ontario that have various naturally occurring gases in subsurface formations.

The **Wells Regulation** requires that the person constructing the well notify the well purchaser, the owner of the land on which the well is located and the Director if natural gas is encountered.

Natural gas or other gas is a gas produced from a well that has the potential to create conditions for explosions, poisoning, fire, asphyxiation or other adverse effects at the well site, within the water distribution system connected to the well or within buildings connected to wells. Some problematic gases that have been found in wells in Ontario include methane, hydrogen sulphide, propane, butane, benzene, carbon dioxide and other hydrocarbon based gases.

Watch for any of the following signs that may indicate the well has encountered contaminants, gas or poor quality water:

- Discolouration or milky colour of the water
- Air bubbles in the water
- Sheens on the water
- Soil staining
- Unexpected or foul smell
- Hissing or degassing sounds

Best Management Practice – Gas Detection Equipment

There is a variety of direct reading instruments used for gas detection including the following:

- combustible gas indicators to measure the risk of fire and explosion, and
- oxygen deficiency meters to assess the level of oxygen in the air.

It is important that the person constructing the well be familiar with:

- gas detection equipment and its limited use and operation, and
- the geographical area and types of naturally occurring gases that may be encountered.

This information may be available from well records and existing hydrogeological reports.

It is also important that the person constructing the well use the gas detection equipment during any well construction.

Best Management Practice – Stop and Report if Contamination or Gas is Encountered

If contamination or gas is encountered during the construction (including alteration) of the well, it is important to stop work immediately and contact the Ministry of the Environment and its Director through the ministry's Spills Action Centre (SAC) at 1-800-268-6060. The Ministry can offer assistance and notify other agencies to help reduce serious dangers to the site crew, well owner and the environment.

- SAC is available to take calls 24 hours/day, 365 days/year.

Best Management Practice – When Constructing the Hole in Areas Prone to Explosive Gases

To minimize the risk of gas causing an explosion or fire, a drilling system that uses a water based drilling fluid may be needed to temporarily contain and control the gas during well construction. As each environment is different, it is also important to seek additional advice from a *Professional Engineer* or *Professional Geoscientist* on the gas issue before starting or proceeding further with the construction of the well.

See Chapter 13: *Well Records, Documentation, Reporting & Tagging*, for further information on reporting natural gas.

Casing

The **Wells Regulation** defines casing as pipe, tubing or other material installed in a well to support its sides, but does not include a well screen.

Casing acts to stabilize the hole, prevents unconsolidated overburden materials from entering the well water column, accommodates the pumping equipment, and may be used to seal off or isolate unwanted formations. It is important to seat the casing into the bedrock when the well is obtaining groundwater from bedrock formations.

Casing Materials

It is important that casing material be able to withstand the stress and weight of the formation with depth, any corrosive properties of the formation and groundwater, and seasonal changes such as freezing and thawing.

Making the casing choice that is best for the specific situation involves consideration of the formation, the production capacity of the aquifer, the water uses planned for the well, the size of the hole, and many other factors. Once determined and installed, the type, depth and specifications of the casing used must be recorded on the well record.

The **Wells Regulation** sets minimum construction requirements for casing in new wells.

The **Wells Regulation** requires that casings in new wells must:

- Be made of new materials.
- Be clean and contaminant free
- Not impair the quality of the water. Casing joining materials must also not impair the quality of the water.
- Be watertight. Any casing joints and seams must be permanent and also watertight.
- Be clean and free of contamination. This includes the removal of all visible debris and material prior to the installation of the casing in the hole.

Best Management Practice – Cleaning Casing

Casing and equipment can be disinfected by following the instructions found in the American Water Well Association Standard C654 titled *Disinfection of Wells*[9].

Additional information on disinfection of equipment can be found in Chapter 8: *Well Disinfection,* in the “Initial Steps for New Wells” section.

[9] American Water Works Association (AWWA). 2003. *ANSI/AWWA C 654-03 - Disinfection of Wells*. AWWA, Devner, CO. 2003. www.awwa.org

Casing must be properly sealed into the bedrock to prevent overburden and other foreign materials from migrating under the casing into the well and potentially impairing the quality of the groundwater and water in the well.

Examples of properly sealing the well casing to the bedrock include:

- Seating the bottom of the well casing with a drive shoe into competent bedrock below the top of the overburden/bedrock interface.
- Placing bentonite or a cement product that is suitable for the environment in the annular space at the overburden/bedrock interface.
- A combination of seating the bottom of the well casing and placing a bentonite or cement product in the annular space at the overburden/bedrock interface.

Best Management Practice – Ensuring the Casing is Sealed in the Bedrock

To ensure that the casing is properly sealed into the bedrock use one or both of the following methods:

- Downhole video camera for visual confirmation, and/or
- Hydraulic packer testing (i.e. sealing the well with an inflatable packer immediately below the well casing and filling the well column above the packer with water. If the water level or pressure in the casing drops then the bottom of the casing is not sealed).

The **Wells Regulation** sets minimum specification standards including wall thicknesses for different types of casing materials in new wells including steel, concrete, fibreglass, and plastic. The casing standards are shown in Table 5-1 and the descriptions with advantages and disadvantages are shown in Table 5-7. Only those casing materials listed in Table 5-1 are considered suitable casings for any well except a test hole or dewatering well.

Table 5-7: Advantages and Disadvantages of Different Types of Well Casing

Casing Material	Characteristics	Advantages	Disadvantages
Steel 	Typically used in drilled wells Wall thickness requirements and relevant standards in Table 5-1: Minimum Casing Specifications for New Well Construction	• Very strong, durable, rigid • Less temperature sensitive than PVC, PTFE or fibreglass • Less expensive than stainless steel • Commercially manufactured well screens available	• Is subject to oxidation (rusts) • May react with metals • May be subject to corrosion (e.g. bi-metallic, pitting, stress) in environments that have: o elevated hydrogen sulphide, o low pH, o high dissolved oxygen content, o total dissolved solids >1,000 mg/L, o carbon dioxide >50 mg/L, and o combined chloride, bromide and fluoride >500 mg/L • Requires skilled welder to join casing sections together unless the sections are threaded
Stainless Steel 	Typically used in drilled wells and in highly corrosive environments so that the life of the well is increased Wall thickness requirements and relevant standards in Table 5-1: Minimum Casing Specifications for New Well Construction.	• Less subject to corrosion than steel • Does not rust • Non-reactive to most chemicals • Very strong, so may be used in clay installations • Less temperature sensitive than fibreglass • Commercially manufactured well screens available	• Relatively expensive • Heavy to transport and work with • May react with metals • May be subject to corrosion when exposed to the following over a long term: o iron bacteria and/or other microorganisms, and o low pH and/or other geochemical conditions (see Steel above) • Requires skilled welder to join casing sections together unless the sections are threaded

Casing Material	Characteristics	Advantages	Disadvantages
Concrete 	• Must be fully cured and commercially manufactured • Typically manufactured precast tile that has been reinforced • Tiles must be joined using mastic sealant that remains pliable, is waterproof, is approved for potable water use by NSF International and installed following manufacturer's recommendations • Typically used in bored and dug wells Wall thickness requirements in Table 5-1: Minimum Casing Specifications for New Well Construction	• Stable • Properly designed manufactured precast tile provides good compressive strength • Readily available	• Prone to cracking • Subject to heaving • Heavy to move • Difficult to make permanent watertight joints
Thermal plastic – PVC 	• Built to a physical standard that gives all sizes of pipe of the same collapse resistance within a strength standard • Must be approved for potable water use The **Wells Regulation** does not permit the use of large diameter corrugated plastic pipe that is not approved for potable water use as casing for a new well Wall thickness requirements and relevant standards in Table 5-1: Minimum Casing Specifications for New Well Construction	• Corrosion resistant • High abrasion resistance • Does not leach • Strong in most environments • Flexible • Light weight to transport and work with • Takes threads well • Inexpensive • Centralizers available to centre the casing in the hole • Commercially manufactured well screens available	• May fail under high pressure • May fail under high temperatures (e.g. during cement grouting of annular space) • May degrade when exposed to ultraviolet rays • Not suitable for driven wells

Casing Material	Characteristics	Advantages	Disadvantages
ABS (Plastic) 	• Built to a physical standard that gives all sizes of pipe of the same collapse resistance within a strength standard • Must be approved for potable water use Wall thickness requirements and relevant standards in Table 5-1: Minimum Casing Specifications for New Well Construction	• Same advantages as PVC but better impact strength, better heat resistance and lighter weight	• Same disadvantages as PVC
Fibreglass 	• Must be manufactured from virgin resin and fibres • Must be approved by the NSF International for potable water use[10] • Casing needs to withstand tons of pressure exerted by the natural ground, especially with depth • Joined by male and female joint "spigot," screws and epoxy. The epoxy must not impair the quality of the water with which it comes in contact Wall thickness requirements in Table 5-1: Minimum Casing Specifications for New Well Construction.	• Higher strength to weight ratio than galvanized casing • Resists corrosion	• Off the shelf fibreglass casings may not be used in certain conditions – see the best management practice following this table

[10] NSF International Standard/American National Standard 61, 2008. *Water Treatment and Distribution Systems - Health Effects*. NSF International, Ann Arbor, MI 2008. www.nsf.org: Certified fibre-reinforced plastic casing for potable water use (see NSF Products and Service Listings at URL: http://www.nsf.org/Certified/PwsComponents/

Casing Material	Characteristics	Advantages	Disadvantages
Galvanized Steel 	• Typically it is made up of wound/spiral casing and the seams must be welded to make the casing watertight • Strength comes from corrugated shape. • Galvanized steel casing is made by electroplating the steel with zinc • There has been some concern that use of galvanized steel pipe can be the source of metals in well water such as lead or arsenic. The MOE is not aware of arsenic hazards with galvanized steel in well water. To minimize the risk of heavy metal exposure and to meet the **Wells Regulation** requirement of not impairing the well water quality, it is important that electroplated casing using zinc with low levels of lead and other impurities be chosen. Currently the Ministry of the Environment and World Health Organization[11] guidelines indicate galvanized steel casing does not create a well water health related concern and is an acceptable casing depending on the environment and well design.  Wall thickness requirements and relevant standards in Table 5-1: Minimum Casing Specifications for New Well Construction	• Can be strong depending on the environment	• Susceptible to corrosion • Requires skilled welder to join casing sections and seams together • Should not be used in corrosive water environments since the protective coating will eventually disappear and cause the casing to rust and deteriorate

[11] World Health Organization. 2006. *Guidelines for Drinking-water Quality, First Addendum to the Third Edition, Volume 1, Recommendations* - 3rd Edition, ISBN 92 4 154696 4 (NLM Cassification: WA 675) Electronic version for the web available at www.who.int/water_sanitation_health/dwq/gdwq0506.pdf. Pages 181, 182, 183 and 219

Best Management Practice – Proper Use of Fibreglass Casing

It is the responsibility of the well technician to ensure the fibreglass casing is appropriate for the geologic environment and well depth. It is important that persons constructing wells consult with the manufacturers who make fibreglass casing for wells. For particular wells, persons constructing wells should inform the manufacturers of the depth of the well casing into the ground and the geological environment. To reduce the risk of well casing collapse, the fibreglass manufacturer should recommend a casing design for the installation. It is important that the person constructing the well then follow the recommendations from the manufacturer.

Best Management Practice – Proper Use of Concrete Casing

Consider using concrete tiles designed to ASTM C478–07 titled *Standard Specification for Precast Reinforced Concrete Manhole Sections*[12].

It is important to ensure the structure of the concrete tiles are sufficient to prevent well collapse.

Concrete tiles should be carefully and evenly backfilled on the outside to ensure the tiles remain plumb.

[12] ASTM Standard ASTM C478-07 (2009). "*Standard Specification for Precast Reinforced Concrete Manhole Sections*" ASTM International, West Conshohocken, PA, 2009, DOI: 10.1520/C0478-07, www.astm.org

Joining Casing Lengths

Well Casing Joints for New Wells

Ontario

Joints in casing are not allowed, unless the joints:

- Achieve a permanent, watertight bond, such as welded steel joints, and
- Are made so that the jointed casing does not impair the quality of water with which it comes in contact.

Joints for Concrete Casing in New Wells:

Ontario

If the casing is concrete:

- it must be fully cured and commercially manufactured,
- the concrete sections must be properly aligned so the joints are flush and the casing is centred and plumb, and
- the sections must be joined with a mastic sealing material (typically butyl rubber material) that remains pliable and waterproof and is approved for potable water use by NSF International Standard - NSF 61.

After the casing length has been attached, additional sand/cement mortar mixes could also be placed on the outside of the casing joint area to help seal the joint.

Best Management Practice – Proper Joining of Concrete Casing

All concrete tile joints should be designed to ASTM C990–06 titled Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants[13].

For unsealed joints in concrete tiles used as well screens see the section "Well Screens using Large Diameter Concrete Tiles," on page 70 of this chapter.

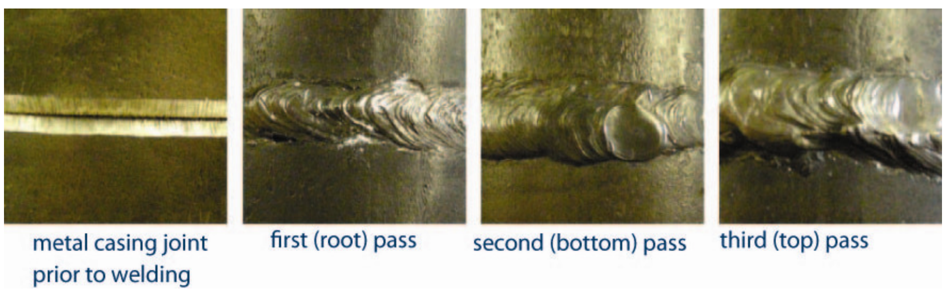
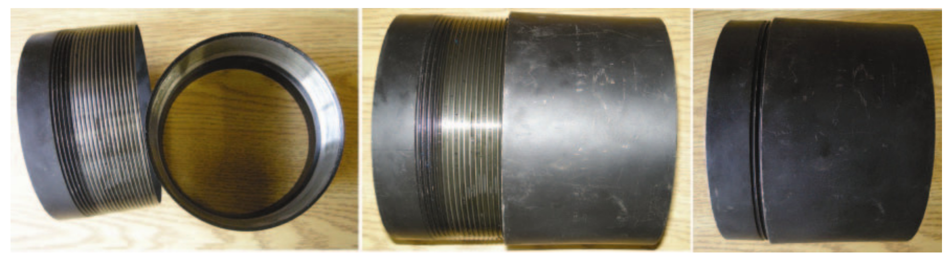
Table 5-8 provides suggestions and photographs for achieving watertight joints.

Even though Table 5-8 provides suggestions for joining casing, a person constructing a well should determine the type of bond used to seal the joint, or if the casing should even have joints, depending on the well design, environmental conditions and formation.

[13] ASTM Standard C990M, 2006 (2009). *Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants*. ASTM International, West Conshohocken, PA, 2009, DOI: 10.1520/C0990-09, www.astm.org.

Table 5-8: Suggestions for Achieving Permanent Watertight Joints

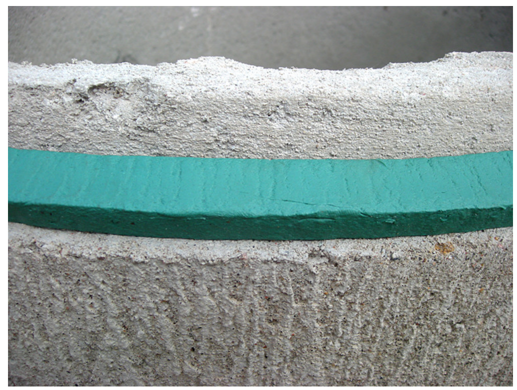
Follow the manufacturer's specifications regarding how to create permanent watertight joints between casing sections. Some suggestions for achieving permanent watertight joints follow:

<table>
<tr><th>Casing Type</th><th>Method for Achieving Permanent Watertight Joints</th></tr>
<tr><td>Steel Casing</td><td>Types of joints:
• Threaded flush-joint
• Bell-end
• Plain
• Square-end
When welding, use appropriate welding rod for creating the casing joints</td></tr>
<tr><td>Steel Casing – welded using three passes

</td><td>Steel Casing – threaded
</td></tr>
</table>

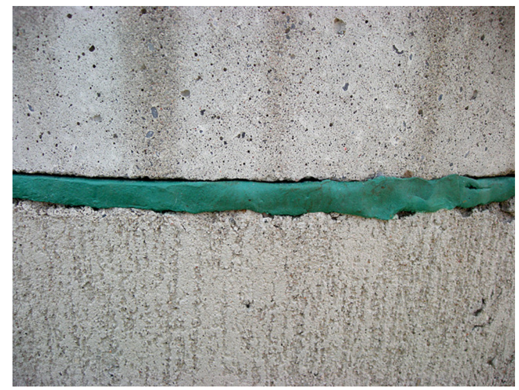
Casing Type	Method for Achieving Permanent Watertight Joints
Concrete	Typically joined using bell and spigot method (see fibreglass casing type below). Use mastic sealant (typically butyl rubber material) that is approved for potable water use by the NSF International Standard 61. Concrete tile joints should be designed and sealed to ASTM C990–06 titled *Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.*

Roll of Mastic Sealant

Mastic Sealant Placed on Concrete Tile Joint – Open



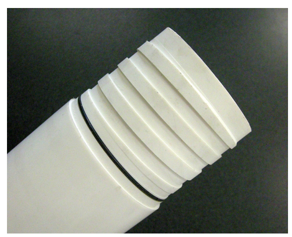
Two Tiles Sealed Together with Mastic Sealant

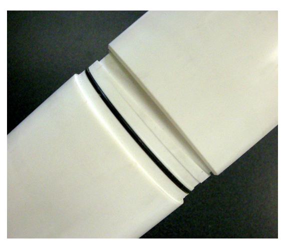


Casing Type	Method for Achieving Permanent Watertight Joints
Plastic	Types of joints: • Flush-joint • Threaded flush-joint • Plain • Square-end • Bell-end For PVC, use O ring on male thread as per ASTM Standard *Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), Schedule 40 and Schedule 80* F480–06B or tapered thread seals on shoulders or PVC primer and glue that is approved for potable water use by the NSF International For ABS use ABS primer and glue that is approved for potable water use by the NSF International See best management practice following this table.

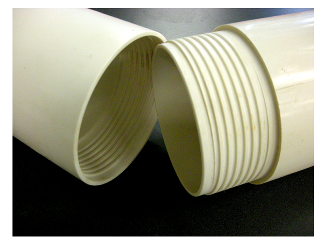
PVC and Solvent Cement (must not impair the quality of the water with which it comes in contact).

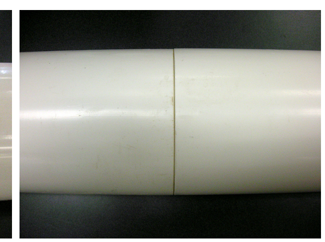
PVC O-ring (no solvents used)





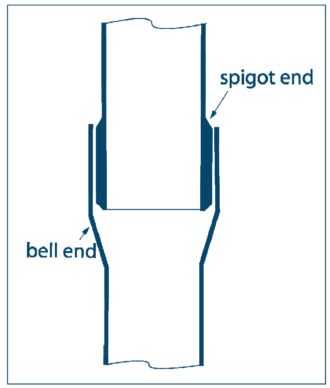
PVC Threaded (no solvents used)





Casing Type	Method for Achieving Permanent Watertight Joints
Fibreglass	Joined by male and female joint "bell and spigot". The casing sections are attached with screws and also sealed with an epoxy. The epoxy must be a material that does not impair the quality of the well water





Best Management Practice – Joining Sections of PVC Casing

When joining sections of PVC casing, follow ASTM Standard *Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR)*, *Schedule 40* and *Schedule 80*, ASTM Standard F480, ASTM, West Conshohocken, PA, 2004u.

Improper Casing for New Well Construction

There are some commonly used casing materials that are not allowed for new well construction. Some examples of improper casing include large diameter perforated corrugated pipe (culvert) that is not approved for potable water use; plastic casing that is not approved for potable water use; hand lain stone, bricks or wood. Figures 5-5 to 5-12 provide examples of improper casing used in wells.

Figure 5-5: Interior of a Well with Plastic Corrugated Pipe

Figure 5-6: Perforated Hole in Plastic Corrugated Pipe

Figure 5-5 shows the interior of a well with plastic corrugated culvert pipes used as casing to support the new well's sides. Note the two pieces of corrugated pipe separated to allow waterlines and a cloth material into the well. Figure 5-6 shows a pen placed in a perforated hole in the plastic casing. The separated casings and perforated openings allow for foreign materials and contaminants to enter the well. Plastic corrugated pipe is also not approved for potable water use and thus, there is a potential for the piping itself to impair the well water.

Figure 5-7: Installing Not Approved Galvanized Casing

Figure 5-7 shows a person installing galvanized steel casing into a well. However, the spiraling seam in the galvanized casing (typical of a cardboard tube holding a roll of paper towel or holiday paper) has not been welded. The seam is not watertight and allows for foreign materials and contaminants to enter into the well. In addition, the individual is not employing proper safety procedures when working within the excavation of the well.

FIGURE 5-8: PLASTIC CASING – TYPE NOT APPROVED

FIGURE 5-9: PLASTIC CASING – TYPE NOT APPROVED

Figure 5-8 and Figure 5-9 show pictures of plastic casing extending out of the top of drilled wells. The plastic pipe is not approved for potable water use and thus, there is a potential for the piping itself to impair well water. If the plastic pipe is approved casing, it will have labeling that identifies the pipe as approved for potable water use. Also, in both figures, the plastic pipe has been attached improperly to steel casing by a clamping device. The attachment has a space that is not watertight and can allow for surface water and other foreign materials to enter the well and impair the well water.

FIGURE 5-10: HAND LAIN STONE USED AS CASING – NOT APPROVED

Figure 5-10 shows hand lain stone used as casing. The openings between the stones allow for foreign materials and contaminants to enter into the well. The stone work may also not be structurally adequate to prevent collapse of the well over time. Also, the well cover consists of open wooden pallets that can allow surface water and other foreign materials a route of access into the well leading to the impairment of the well water.

FIGURE 5-11: WELL WITHIN ANIMAL FEEDLOT – NON-COMPLIANT

In Figure 5-11 the well is the building with the pitched roof on the left side of the photograph. The rectangular structure is located within an animal feedlot area. The well was used as a source of drinking water for human consumption. See Figure 5-12 for a discussion of the unapproved casing.

FIGURE 5-12: INSIDE THE WELL WITHIN ANIMAL FEEDLOT – UNAPPROVED CASING

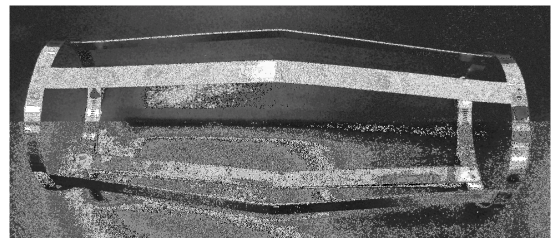
Figure 5-12 shows the interior of the well (building in Figure 5-11). This photograph shows that the well water is a very dark grey colour. Foreign material is floating on the well water. The sides of the well are supported by green painted wooden signs and wood poles. A waterline is extending out of the well water towards the top of the photograph and white styrofoam insulation lies over the well water. The wood used as casing allows for foreign materials and contaminants from the feedlot to enter into the well and impair the well water.

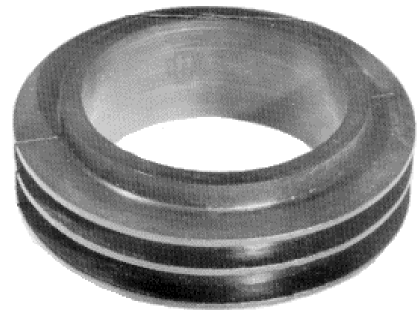
Casing Accessories

Table 5-9 provides details on the most common casing accessories.

Table 5-9: Casing Accessories

Casing Accessory	Characteristics	Graphics
Drive Shoes	Protects the bottom of the casing from damage when pushing the casing into the ground and helps to seat the casing in bedrock formations Types of Drive Shoes: • Rotary or Cable Tool – Can be welded or threaded on in heavy duty or standard pattern • Other special application types include Dual Rotary Shoe and Eccentric Shoe Considered to be casing under the **Wells Regulation** definition	 Cable Tool Drive Shoe  Rotary Drive Shoe
Weld Rings	Increases the surface of the weld to make it stronger Facilitates the welding of casing extensions in well pits Disadvantages include higher cost Considered to be casing under **Wells Regulation** definition Must ensure minimum annular space is based on the widest part of the weld ring	

Casing Accessory	Characteristics	Graphics
Casing Centralizers	Used to center casing in hole to ensure even placement of suitable sealant around casing and formation stabilizer around the well screen	 
Breakaway Guide	A device that aids in proper alignment of the casing when using a cable tool rig by centering the casing. It must not impair the quality of the water with which it comes into contact and it must be placed 2 m (6.5′) above the bottom of the casing The breakaway guide is placed 2 m (6.5′) from the bottom of the leading casing during installation	
Shale Trap	Placed above screen assembly in annular space to prevent suitable sealant from entering the formation and well screen Can be used to isolate or seal off poor quality groundwater zones above the well screen or water intake zone	

Casing Accessory	Characteristics	Graphics
K-Packer Device	Rubber rings installed around a casing Used to isolate or seal off poor quality groundwater zones	
Examples of casing for drilled wells with different wall thicknesses	If not known, the wall thickness can be determined by calculating the difference between the outer diameter and the inner diameter divided by 2 The casings to the right are marked with their wall thickness	

Casing Installation Techniques

Casing is installed using one of two techniques:

1. **Forcing** – the forcing techniques include driving, jacking, pushing and rotation.
2. **Lowering** – into an over sized hole.

Extreme care must be used when handling a long string of casing. In deep wells (e.g. 200 m) this is a concern for lighter casing materials (e.g. PVC) as well. Devices that require tension alone to hold and secure casing (such as slings and chains) should not be used. Instead, it is advisable to use proper casing elevators.

Centering the Casing

Best Management Practice – Centering the Casing

During installation, it is important to ensure casing is centred and vertically plumb in the well. For centering casing in drilled wells, it is important to use and properly attach centralizer devices (see Table 5-8, above) to the outside of the casing. It is important that centralizer devices are made of material that will not impair the quality of the water. Proper centering and alignment of the casing in a vertical plumb hole will create an appropriately sized annular space that is consistent around the entire well casing. An appropriately sized annular space allows for even placement of filter pack materials and sealant (grout) around the casing.

General Guidelines for Using the Breakaway Guide:

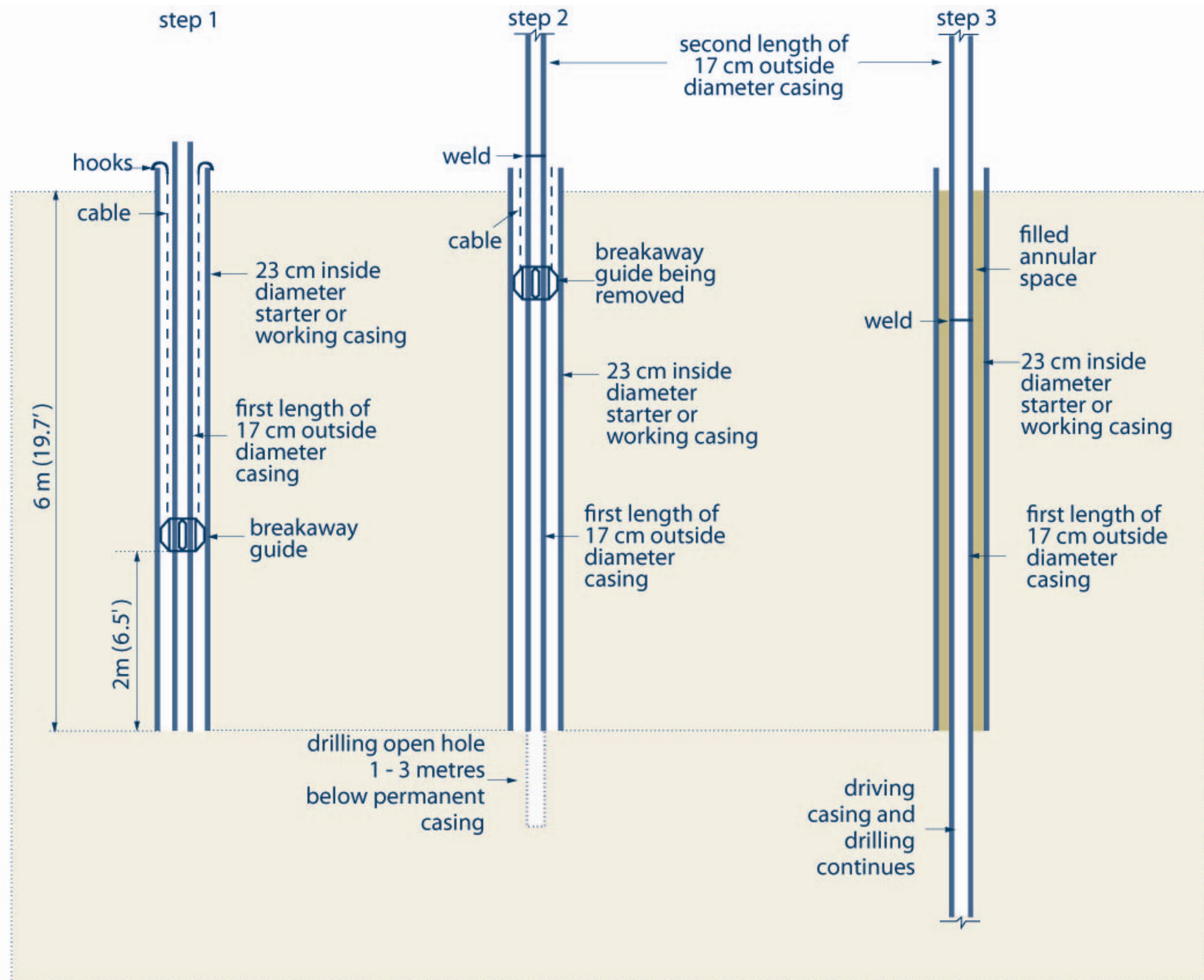
In some cases a breakaway guide (Figure 5-13) can be used in wells constructed by a cable tool drilling rig. When using these guides it is important to:

- Install the working (also called starter or surface) casing as plumb as possible into the hole. The working casing should be used to collar the hole and create a hole that is at least 5.1 cm or greater than the outside diameter of the permanent casing.
- Ensure that the drill string is centred in the hole.
- Place the breakaway centralizer guide over the first section of permanent casing so that it is 2 metres above the bottom of the first permanent casing.
- Install the permanent casing into the well. The breakaway guide is held by cable hooks that rest on the top of the working casing.
- If required, hold the permanent casing at the top with a casing elevator. Drilling the open hole out the bottom of the first permanent casing should continue until the open hole begins to collapse (e.g. 1m – 3 m).
- Weld a second length of casing to the first permanent casing.
- Pull out the breakaway centralizer guide using the cables and hooks.
- Fill the annular space with suitable sealant (see Chapter 6: *Annular Space & Sealing*).
- Continue drilling and advancing casing sections while keeping the sealant (grout) column in the annular space topped up to ground surface during well construction.
- Pull the working casing and top up sealant (grout) to the ground surface when the well is finished.

Figure 5-13 shows a cross-section diagram of this process. The diagram uses the example of a well that is greater than 6 m deep and has a hole diameter (created by the outside diameter of a working casing) slightly greater than the minimum requirement of 5.1 cm larger than the finished permanent casing.

All figures and diagrams are for illustrative purposes only and do not necessarily represent full compliance with other requirements found in the **Wells Regulation**.

FIGURE 5-13: EXAMPLE OF THE USE OF A BREAKAWAY CENTRALIZER GUIDE



- The first weld must be able to pass through casing centralizer guide.
- The casing in step 2 is held in place by the use of an elevator.
- The starter, or working, casing must be removed before the structural stage of the well is complete.
- The outer diameter of starter or working casing makes the hole diameter at least 5.1cm (2”) greater than the permanent casing.

The diagram above is not to scale and is for illustrative purposes for this chapter only.

Well Screens

To prevent water bearing formation collapse into the well and significantly reduce sediment or particles in the well water, it is important to install a well screen in all unconsolidated formations, in most semi-consolidated formations and sometimes in bedrock.

The **Wells Regulation** defines a well screen as perforated pipe or tubing, unsealed concrete tiles or other material installed in a well to filter out particulate matter and form the water intake zone.

The **Wells Regulation** requires that well screens for new wells must be made of new materials that are clean and contaminant free. The materials must not impair the quality of the water.

Best Management Practice – Cleaning Well Screens

Well screens, filter packs and equipment should be disinfected by following the instructions found in the most recent version of the American Water Works Association Standard C654 titled *Disinfection of Wells*.

ASTM Standard D5088 *Standard Practice for Decontamination of Field Equipment Used at Non-Radioactive Waste Sites* is normally for test holes, however, it can be used for any well screen to remove substances such as cutting oils, solvents, lubricants, waxes and other chemical residues.

Well screens that are permitted for use in wells are as follows:

- Commercially manufactured well screens
- Casings that are slotted or perforated to create well screens
- Concrete casings with unsealed joints to create well screens (see "Best Management Practice – Groundwater Entering Large Diameter Wells Cased with Concrete Tiles" on page 70 of this chapter).

Well Screen Design Considerations for Drilled Wells

Well Screen Slots, Length and Diameter

Well screen openings (or slots), screen length, and diameter are all selected to allow water to pass through a screen with the least friction, keep out aquifer formation material, and serve as a structural support for the well. Figure 5-14 on page 64, shows a sample of a telescopic well screen. Telescopic well screens are designed to be pushed out the bottom of the well casing. Other well screens are attached to the bottom of the first length of the well casing.

Manufactured well screens are made of steel or plastic. The slots in the well screens may be designed as continuous, louvered, bridged, milled (vertical) and slotted plastic. Table 9.15 on page 398 of *Groundwater and Wells: Third Edition*[14] provides open areas of the different screen slots.

Under certain circumstances and when properly installed, plastic well screens provide wells with adequate structural strength, good hydraulic characteristics, and long life. To prevent the impairment of the well water and aquifer as required by the **Wells Regulation**, it is important that plastic well screens be approved for potable water use. To ensure sufficient structural strength, it is also important to contact the screen manufacturer for recommended wall thicknesses when plastic well screens are used.

Manufactured continuous-slot screens have larger open areas compared to the other types of screens. Smaller openings reduce yield, increase drawdown and make well development difficult. Continuous-slot openings are also V-shaped in design. The V-shaped opening allows the open area to widen into the screen. This slot design reduces clogging from elongated or oversized particles.

To ensure optimum use, the well screen entrance velocity needs to be calculated to prevent friction loss and increased rates of encrustation and corrosion.

Best Management Practice – Recommended Maximum Entrance Velocity for Well Screens

It is important that the screen should have a maximum entrance velocity that does not exceed 0.03 metres per second (or 0.1 foot per second) to reduce friction loss and rates of encrustation and corrosion.

The size of the screen slots is determined based on an analysis of the aquifer formation materials. The screen slot size is matched to the grain size distribution of the aquifer formation.

The function of the slot size is important in the well screen. Small openings limit well yield while large openings may not prevent the fine material from entering the well. As a general rule, the slots are sized as shown below in the criteria for selecting a well screen for a drilled well. Then, the formation is developed around the well screen to remove the fines through the screen, leaving the coarser material around the outside of the well screen slots.

[14] Sterrett, Robert J. 2007. *Groundwater and Wells: Third Edition.* Johnson Screens/ a Weatherford Company. St. Paul, Minnesota.

Criteria for selecting a well screen for a drilled well include the following:

- Large percentage of open area
- Generally, where the uniformity coefficient (see definition below) is:
  - >6, the slot size needs to retain no less than 50% of the formation material
  - 3 -6, the slot size needs to retain no less than 60% of the formation material
  - <3, the slot size needs to retain between 70% and 90% of the formation material
- Length of screen
- Planned yield of the well
- Non-clogging slots
- Resistance to corrosion
- Sufficient column and collapse strength
- Ease of well development
- Low potential for encrustation in the formation
- Low head loss through the screen
- Ability to prevent formation collapse during development and when pumping the well

Uniformity coefficient is the ratio of the sieve size that retains 40% of the formation material (passes 60% = D_{60}) to the sieve size that retains 90% (passes 10% = effective size)[15].

Best Management Practice – Designing a Well Screen for Drilled Wells to Achieve a Sand-free State

To ensure the well screen chosen will not collapse and will prevent sediment from entering the well water, which could impact the pump operation and water quality, it is important for the person constructing the well to do the following:

- Only select a well screen that is commercially manufactured
- Ensure that the manufacturer of the well screen being used specializes in overburden grain size analysis, screen slot size and screen design
- Provide manufacturers with well depth and samples of the formation to be screened, or the results of a proper grain sieve analysis
- Determine if an artificial filter pack (page 65) is necessary to decrease sediment entering the well and to increase well efficiency
- Make the appropriate selection of manufactured screen material, opening, length and diameter with the assistance of the manufacturer

[15] McCarthy, David F. 1998. *Essentials of Soil Mechanics and Foundations – Basic Geotechnics: Fifth Edition.* Prentice Hall. Upper Saddle River, New Jersey. Page 96.

Riser Pipes, Leading (or Lead) Pipes, K-Packers and Plugs for Telescopic Well Screens

A typical manufactured telescopic well screen assembly (shown in Figure 5-14) is installed through the casing of a drilled well. It will consist of the three following sections:

- A properly sealed plug is located at the bottom of the screen to prevent formation material from entering through the large opening at the bottom of the screen. The plug is sealed by either being threaded in or by pressure fitted onto the bottom screen. The plug should be made of a material (e.g. iron) that can be drilled out of the well for well rehabilitation and abandonment reasons.
- The plug is sealed to a slotted section that has a precisely selected slot size and length.
- A riser pipe is attached above the slotted section of the well screen. The top of the riser pipe is located close to the bottom of the well casing.

A K-packer (shown in Figure 5-14 and Table 5-9) is a commercially manufactured fitting that creates a watertight and sand-tight seal between the riser pipe and well casing. K-packers are commonly made of neoprene rubber, EPDM rubber or rubber and steel. In some cases packers have been made of lead (Pb). However, well screen material including the K-packer cannot impair the quality of water with which it comes in contact. As lead (Pb) is a contaminant that can leach into the well water, lead (Pb) packers can no longer be used in new well construction.

Best Management Practice – Packer Devices for Telescopic Well Screens

It is recommended that multiple (two or more) K-packers are used to eliminate the problems created by variations in casing or packer dimensions.

During installation, rubber rings (gaskets) of the K-packer can become damaged by contact with weld slags or beads within casing joints. To reduce damage to the K-packer, it is important to apply a non-toxic (i.e. food grade) lubricant to the rubber rings that will not impair groundwater quality.

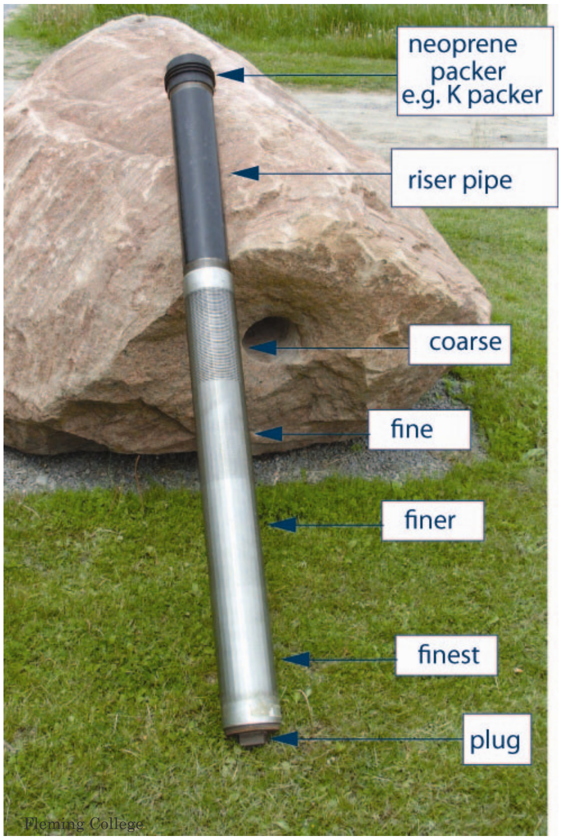


FIGURE 5-14: MANUFACTURED TELESCOPIC WELL SCREEN SAMPLE FOR DRILLED WELLS

Figure 5-14 shows a sample telescopic screen with multiple slot sizes (from coarse to finest). A typical well screen for domestic use in well construction does not have multiple slot sizes on a small length of screen.

A short section of lead or leading pipe [e.g. 1m (3′) long) can be added to the bottom of the well screen assembly to create a sump. The term “lead pipe” is not the metal element Pb, but rather a pipe, typically made of stainless steel, that is leading or ahead of the well screen in the hole.

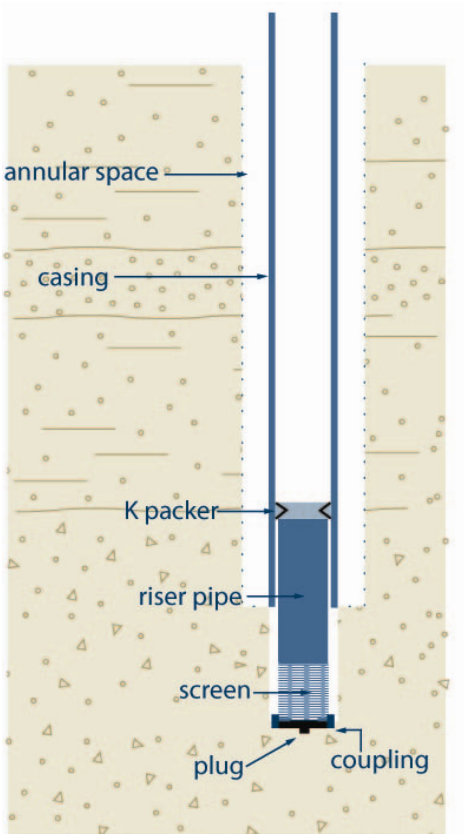


FIGURE 5-15: AN EXAMPLE OF A TELESCOPIC WELL SCREEN ASSEMBLY

The diagram above is not to scale and is for illustrative purposes for this chapter only. Also, the diagram shows the well only partially completed.

All figures and diagrams are for illustrative purposes only and do not necessarily represent full compliance with other requirements found in the Wells Regulation.

FILTER PACKS AROUND WELL SCREENS FOR DRILLED WELLS

Filter packs are well sorted gravels or coarse sands that can be:

- Developed around the well screen (naturally developed from native granular material),
- Selected and placed into the hole surrounding the well screen and developed (see "exploded view A" in Figure 5-22 on page 90) (artificial filter pack), or
- Pre-packed between two manufactured well screens (called pre-packed well screens) and developed.

This packed zone separates the well screen from the natural aquifer material to prevent finer materials from entering the well and increases the effective well diameter. The filter pack should extend several metres above the top of the screen to allow for settling during development.

Ontario The filter pack must be no closer than 6 m (19.7′) to the top of the ground surface, or in the case of a shallower well, no closer than 2.5 m (8′) to the top of the ground surface.

ARTIFICIAL FILTER PACKS

There are circumstances where the use of artificial filter packs is preferred over a naturally developed filter pack. For example:

- Well screens with small screen slots are used with formations having uniform fine grained material. Small slot sizes can create low well efficiency and could reduce the chance of obtaining the desired yield.
- Open hole wells in semi-consolidated bedrock formations can have significant quantities of granular material released off the hole wall. The granular material can enter the water distribution system damaging the pumping equipment and impairing the water quality.

Persons constructing wells can remove formation material around a well screen and replace it with a relatively thin zone of coarse material to increase the well's efficiency, increase hydraulic diameter and prevent granular material from entering the well. The coarse material that is placed around the well screen is called an artificial filter pack.

As an alternative to placing coarse material around the well screen, the person constructing the well can install a manufactured pre-packed well screen.

Ontario The **Wells Regulation** requires artificial filter pack material to be clean, washed gravel or sand. The gravel or sand must be placed during or after placement of well screen and casing.

The following best management practices (including Table 5-10) provide artificial filter pack characteristics for obtaining optimum well yield and information on placing artificial filter packs.

Best Management Practice – Optimum Artificial Filter Pack Characteristics

Table 5-10: Artificial Filter Pack Characteristics[16]

Characteristics	Advantages
Clean and Washed (See "clean" in Chapter 2: *Definitions & Clarification*; Table 2-1)	• Reduces loss of material during development • Protects against impairment of water and aquifer • Requires less development time
Well rounded and uniform grains	• Increases porosity • Increases rate of groundwater flow towards well • Increases well efficiency • Reduces drawdown • Increases yield • Increases effective drawdown • Ensures segregation does not occur during placement or development
90 to 95 per cent quartz grains	• Consists of inert material that should not create water quality problems • Reduces risk of dissolution of grains due to geochemistry of groundwater
Uniformity coefficient of 2.5 or less (page 62 for description of term)	• Allows for the proper sized grains to be placed adjacent to the formation. • Allows for larger well screen slots
Thickness of no more than 20 cm (8″)	• Allows for development techniques to penetrate into the formation
Well screen slot size should retain 90% of filter pack grains	• Prevents material from entering well, damaging the pumping equipment and impairing water quality

[16] Sterrett, Robert J. 2007. *Groundwater and Wells: Third Edition.* Johnson Screens/a Weatherford Company. St. Paul, Minnesota.Table 9.17, Page 411.

Best Management Practice – Placing Artificial Filter Pack Material

To place an artificial filter pack around a well screen, the hole needs to be properly sized to allow for the well screen and a sufficiently sized annular space around the well screen. The casing and well screen need to be properly centred in the hole to ensure the person constructing the well places a consistent thickness of filter pack material around the well.

To avoid bridging problems, it is important to place artificial filter pack materials in drilled wells:

- Using a tremie pipe,
- With a reverse circulation of fluids, or
- With a direct circulation of fluids.

If a tremie pipe is used, the tremie pipe needs to be raised slowly as the filter material builds up around the well screen. The distance to the top of the filter pack should be carefully monitored using the tremie pipe or a weighted line inserted through the tremie to feel the top of the filter pack.

If a well casing is being raised to expose a well screen and filter pack to the formation (see the section titeld: “Pull Back Method” on page 74), then consider the following:

- When using a tremie pipe, the artificial filter pack material is usually placed in stages as the outer casing is pulled back exposing the filter pack and screen to the formation.
- A sufficient depth of filter pack material should be maintained above the well screen slots as the casing is withdrawn. The person constructing the well needs to ensure that the level never drops below the outer casing to prevent finer material from entering the well screen.

For more information on filter pack design see Chapter 9 (pages 409 to 419) and Chapter 10 (pages 486 to 491.) of *Groundwater and Wells, Third Edition*[17].

[17] Sterrett, Robert J. 2007. *Groundwater and Wells: Third Edition.* Johnson Screens/ a Weatherford Company. St. Paul, Minnesota.

Well Screen Design Considerations for Large Diameter Wells

Typically, in excavated (dug) and some bored wells, coarse sand or gravel is installed below concrete tiles or other types of casing material to prevent sediment from entering the well water. This area of the well is typically called a stone bed and has the following characteristics:

- It is usually about 30 cm (12″) to 60 cm (24″) thick depending on the environment and well design
- It has to be clean, washed and free of contamination

The following sections provide best management practices for the design of well screens for large diameter wells.

Well Screens using Large Diameter Fibreglass or Galvanized Material

Best Management Practice – Designing a Well Screen Using Fibreglass or Galvanized Casing in Large Diameter Dug and Bored Wells

In most cases groundwater will enter a large diameter well through the open bottom below the well casing. As a result, slotting of the well casing to create a well screen should not be done.

If it is necessary to obtain groundwater through the sides of the well, then it is important for the person constructing the well to contact the manufacturers of fibreglass or galvanized casing before creating a well screen by perforating or slotting the casing. Persons constructing wells with these materials should have manufacturers determine and confirm if the type of slotting or perforating will potentially weaken or collapse the casing (and void the warranty) or cause impairment of the well water.

It is important to follow the manufacturer's specifications when backfilling with clean or washed sand and gravel around the outside of fibreglass and galvanized well screens to prevent collapse and warping in particular environments.

Well Screens using Large Diameter Concrete Tiles

Where the person constructing the well uses concrete tiles as well casing and well screen in bored or dug wells, the well screen begins at the first unsealed joint in the concrete tiles and ends either at the bottom of the unsealed concrete tiles or any gravel or sand installed below the tiles in the excavated hole.

Best Management Practice – Groundwater Entering Large Diameter Wells Cased with Concrete Tiles

Concrete tiles should be:

- Designed to ASTM C478–07 titled *Standard Specification for Precast Reinforced Concrete Manhole Sections*[18]*,*
- Designed in a manner sufficient to prevent well collapse, and
- Carefully and evenly backfilled on the outside to ensure the tiles remain plumb.

Groundwater should only enter a large diameter well through the open bottom below the well casing. Where groundwater is to enter through the open bottom of the concrete tiles, all concrete tile joints should be designed to ASTM C990–06 titled *Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants*[19]*,*

[18] ASTM Standard ASTM C478-07 (2009). *Standard Specification for Precast Reinforced Concrete Manhole Sections.* ASTM International, West Conshohocken, PA, 2009, DOI: 10.1520/C0478-07, www.astm.org

[19] ASTM Standard C990M, 2006 (2009*). Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.* ASTM International, West Conshohocken, PA, 2009, DOI: 10.1520/C0990-09, www.astm.org.

Installing Well Screens In Drilled Wells

Properly sized and installed well screens and filter packs reduce the risk of formation collapse and sediment in well water. Failure to install or properly install well screens has been the cause of many problems associated with drilled wells in Ontario such as well plugging, pump and waterline damage, and sediment or granular material in the water supply.

The method of well screen installation is chosen based on practicality and economic feasibility. A particular well design may limit how a well screen can be installed due to the following:

- Aquifer properties
- Methods used to drill the well
- Size and dimensions of the hole
- Hydraulic conditions

In some situations, multiple screens can be separated by sections of casing. This method has been used in a variety of wells to allow the well to take water from multiple aquifers. This can only occur if there is no annular space below the uppermost well screen.

Some methods of well screen installation include the pull-back, open hole, single string, and bail-down. Table 5-11 provides general information on all of these methods. Outlines of the steps involved in each of these methods are shown following the table.

Table 5-11: Advantages and Disadvantages of Well Screen Installation Methods for Drilled Wells

Methods	Well Construction Equipment	Advantages	Disadvantages
Pull-back	Best suited for drilling systems that advance the casing as the hole is being constructed. Examples include the following: • Cable tool rig, • Air rotary rigs equipped with casing drivers, and • Dual rotary rigs with eccentric bit systems and ring bit systems.	Can minimize problems caused by: • Heaving sediment, • Sloughing of the hole walls, and • Setting the screen at the wrong depth. Makes it possible to remove and replace the screen without disturbing the casing and suitable sealant (grout) placed around the casing. Allows for the installation of a telescopic screen without having to use a temporary casing.	Heaving formation conditions will create installation problems when using a cable tool or air rotary rig. The person constructing the well may have to employ one of the following options to set the well screen: 1. Fill the casing with water. 2. Control fluid loss using prepared drilling fluids. 3. Use weighted drilling fluids (e.g. barite). 4. Move tools (e.g. bailers) very slowly up and down the casing to reduce the chances of sediment heaving up into the well casing. 5. Place the bottom of the casing to the top of a clay layer under the aquifer, if present. Where there is significant side-wall friction this method requires a great deal of force to pull-back the casing.
Open hole **(Double string)**	Used in rotary drilling rigs in unconsolidated material.	Can minimize problems caused from: • Heaving sediment, and • Sloughing of the hole walls. Makes it possible to remove and replace the screen without disturbing the casing and suitable sealant (grout) placed around the casing. Allows for the installation of a telescopic screen without having to use a temporary casing.	Need to use drilling fluid to prevent formation collapse below the well casing. This may make developing more challenging.

Methods	Well Construction Equipment	Advantages	Disadvantages
Open hole **(Single string)**	Used in narrow drilled wells constructed using rotary drilling rigs in unconsolidated material.	Minimizes the risk of complications due to heaving formations when using mud rotary. Screen (pipe size) can be installed as part of the casing assembly.	The string offers little column strength and requires support using drilling tools to prevent well screen collapse and crooked wells. For deeper wells in formations that are prone to collapse, an extra outer diameter casing may have to be installed and grouted for a significant portion of the well. Screen cannot be removed independently of the casing.
Bail-down	Used in cable tool rigs and occasionally in rotary drilling rigs in unconsolidated material. Used when: • The pull back method is not desirable or possible (e.g. significant side-wall friction). • It is difficult to set the screen by single string methods (e.g. high static water level and loose formation materials).	Better than the pull back where significant side-wall friction exists. Better than single string methods where high static water level or loose formation materials exist.	Requires special end fittings for the screen. Requires a special nipple that has right and left hand threads and a coupling with right and left hand threads. Requires annular space to be sealed with suitable sealant before installation can start. May require an extra string of casing to rest on top of the screen and provide extra weight. The lower end of this pipe would likely have to be fitted with a coupling or flange to rest squarely on top of a packer without distorting the packer's shape.
Jetting	Used in jetting wells.	Less expensive than other methods.	Only useful for shallow wells obtaining water from sand formations. Possibility of freezing.
Driving	Used in driven and hollow stem augered wells.	Less expensive than other methods Not a complicated method.	Only useful for shallow wells obtaining water from sand formations. Possibility of freezing. Possibility of creating small annular space (see Chapter 6: *Annular Space & Sealing*).

PULL–BACK METHOD[20]

The general steps involved in the pull–back method (Figure 5-25) are as follows:

1. Install the casing to the full depth of the well. As an alternative, install a temporary casing to the full depth of the well. After the casing is placed in the open hole, any cuttings that settle inside should be carefully cleaned out.

    Installing the casing to the bottom of the well is particularly important if a delay is anticipated between drilling and screen installation. The casing will prevent a partial or full collapse of the formation into the hole.

2. Where a temporary casing has been installed, lower a permanent smaller diameter well casing into the temporary casing to the bottom of the hole. Push a telescopic well screen inside the permanent casing to the bottom. Fill the bottom of the annular space between the temporary and permanent casings with a filter pack material to a height that extends above the well screen.

    A weight should be placed on the bottom of the well screen to stop the well screen from migrating upward while the casing is being pulled back prior to proceeding to Step 3. The weight also creates tension to help the person constructing the well determine the exact position of the well screen during the pull-back procedure.

3.
    a) Where a temporary casing has been installed pull back the permanent casing exposing the well screen and filter pack. Then carefully pull back the temporary well casing to expose the well screen and filter pack to the formation.

    b) In cases where a temporary well casing has not been installed, pull back (or lift) the casing far enough to expose the screen to the water bearing formation. Set the bottom of the casing near the top of the well screen and ensure the joint between the casing and well screen remains sealed.

Some methods of lifting the casing include the following:

- Jarring and then lifting the casing with the drilling tools, a bumping block or drive clamp.
- Lifting the casing using mechanical or hydraulic jacks.
- Using a pulling ring or spider with wedges or slips to grip and lift the casing. Adding clean water to the well during this process may also help.

4. In situations where no temporary casing has been installed, the screen will need to be held in place until it is set in the formation. It is important that care be taken to prevent the movement of the well screen during the development and placement of the suitable sealant in the annular space.

In situations where a temporary casing has been installed and lifted to expose the well screen and filter pack, the temporary casing needs to be fully removed from the well after the suitable sealant has been placed into the annular space (See Chapter 6: *Annular Space & Sealing*).

[20] Sterrett, Robert J. 2007. *Groundwater and Wells: Third Edition.* Johnson Screens/ a Weatherford Company. St. Paul, Minnesota.._Pp.483-485.

Tips for the installation of a telescopic well screen are as follows:

- To ensure extra safety when installing the well screen and maximum exposure of the well screen to the aquifer, a riser pipe (see Figure 5-14) with K-packers should be attached to the top of the screen. The riser pipe and K-packers will seal the top of the well screen to the bottom of the casing and prevent the screen from slipping out of the bottom of the well casing. This will also prevent formation material from entering the well between the well screen and casing.
- When developing the well by surging water into and out of the well screen in loose sand formations, the well screen can easily slip out of the bottom of the casing. The riser pipe and K-packers are especially helpful to hold the well screen in place during development of the well.
- To ensure the well screen is placed in the correct location below the well casing, the depths from the ground surface should be measured very carefully.

All figures and diagrams are for illustrative purposes only and do not necessarily represent full compliance with other requirements found in the **Wells Regulation**.

Open Hole/Double String Method[21]

This method generally consists of drilling below the casing while maintaining drilling fluid in the well to hold the well open below the casing. A telescopic well screen is installed into the open space below the well casing.

The general steps for this open hole method are as follows:

1. The casing is installed into the well and the annular space is filled with suitable sealant (see Chapter 6: *Annular Space & Sealing*). The bottom of the casing is slightly below where the top of well screen will be placed.
2. The casing is filled with drilling fluid (e.g. mud). The well is drilled through the bottom of the well casing to make room for the well screen. In some cases where the formation can be held open (e.g. bedrock, or till), drilling fluid is not necessary.
3. A telescopic well screen is lowered or pushed inside the casing to the bottom of the well. Then the "Tips for the installation of a telescopic screen" on page 75 of this chapter should be followed.
4. If used to hold the hole open, the drilling fluid is removed.
5. The well is then developed.

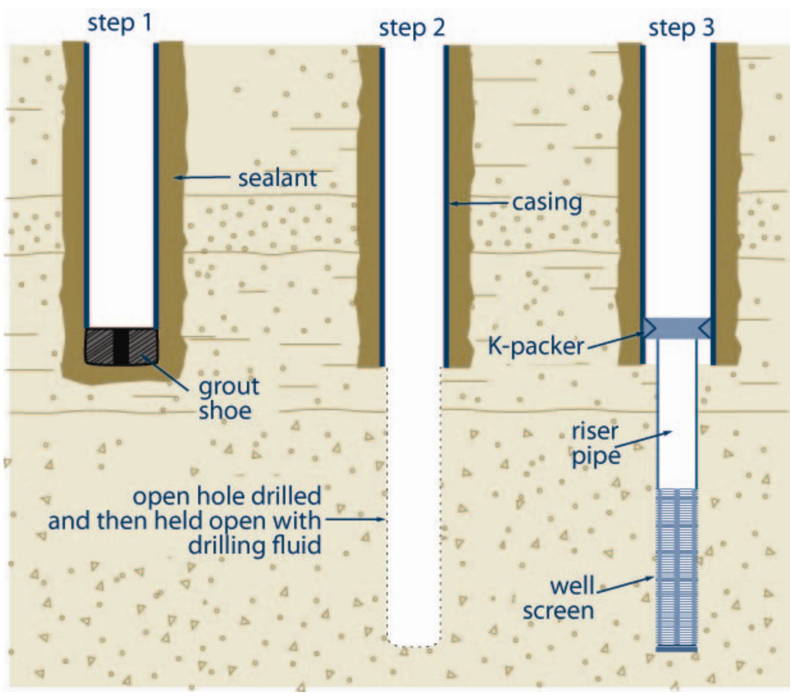


Figure 5-16: Example of an Open Hole, Double String Method of Screen Installation

The diagram above is not to scale and is for illustrative purposes for this chapter only.

[21] Sterrett, Robert J. 2007. *Ground water and Wells: Third Edition.* Johnson Screens/ a Weatherford Company. St. Paul, Minnesota.. Pages 467-468.

Open Hole/Single String Method[22]

The general steps for the open hole/single string method (see Figure 5-17) are as follows:

1. The well screen is attached to the bottom of the first length of casing to be installed in the well as one assembly (i.e. one string). If the well screen is smaller than the casing in diameter, it can be welded or threaded to the casing with a flared weld ring or cone adapter. If the well screen is the same size as the casing, it can be welded or threaded directly to the bottom of the casing.
2. Drilling fluid (e.g. mud) is added into the open well hole to prevent any collapse of the sides of the well. As an alternative, an outer temporary casing can be installed to the bottom of the well.
3. The string is installed in the hole to almost the bottom of the well. Where a temporary outer casing is installed, the inner casing, well screen and filter pack are installed within the outer casing and Steps 4 and 6 do not apply.
4. The drilling fluid is thinned to allow the fluid to enter through the slots of the well screen as the string is lowered into the hole. If drilling fluid does not enter into the well screen, the pressure of the drilling fluid could cause the well screen to collapse.
5. Because the string is long and slender it offers little column strength and it requires lateral support to prevent well screen collapse and crooked wells. When this string is installed in an open hole without side support, the string should be suspended from the surface using casing elevators without resting the string on the bottom of the hole.
6. Once installed, the well screen and casing can be filled with water to displace the drilling fluid.
7. For naturally developed wells, the drilling fluid is removed and the fine material in the formation is induced to enter the well screen leaving the coarser material on the outside of the screen. When artificial filter packs are used, the pack material is placed around the well screen and the lower portion of the well casing. The well development process is similar to naturally developing wells. If a temporary outer casing has been installed, the temporary casing is removed to expose the string and filter pack and then the well is developed.
8. Collapse of the subsurface formation around the string provides lateral support and the full weight of the string can be safely released from the drilling rig.

In situations where a temporary casing has been installed and lifted to expose the well screen and filter pack, the temporary casing needs to be fully removed from the well after the suitable sealant has been placed into the annular space (See Chapter 6: *Annular Space & Sealing*).

[22] Sterrett, Robert J. 2007. *Ground water and Wells: Third Edition.* Johnson Screens/ a Weatherford Company. St. Paul, Minnesota. Page 491.

Tips for string installation are as follows:

- Centralizers can help maintain alignment of the casing and well screen string. Centralizers are recommended for well screens that are >6 m (19.7′) in length.
- If a clay or silt deposit is located beneath the well screen, it is important to prevent the clay or silt from heaving up next to the screen during well development. Two methodologies to prevent clay or silt from entering the well screen are as follows:
  - When placed around the well screen, an artificial filter pack can act as a formation stabilizer to hold the clay or silt deposit in place during development (see the section titled "Artificial Filter Pack" on page 65 of this chapter). The grain size of the filter pack should be chosen as described in Table 5-10: Artificial Filter Pack Characteristics.
  - For wells with a large annular space around the well screen, a shale trap or formation packer can be mounted on the bottom of the casing above the well screen [see Figure 5-22 (C)]. Using this methodology, the formation will collapse around the well screen and below the shale packer. The shale packer will hold the formation in place to prevent heaving of the underlying clay or silt deposit towards the well screen during development[23].

For deeper wells in formations that are prone to collapse, a larger diameter outer casing should be installed and grouted for a significant portion of the well. The lower portion of the well should be drilled through the bottom of the outer casing to the desired depth. It is important that the well casing and open portion of the well hole be filled with drilling fluid. A smaller diameter casing and well screen string is then installed in the well using the same process as described in the general steps.

To eliminate the need to run two strings of casing to install artificial filter pack material, use a pre-packed screen.

[23] Sterrett, Robert J. 2007. *Ground water and Wells: Third Edition.* Johnson Screens/ a Weatherford Company. St. Paul, Minnesota. Page 491.

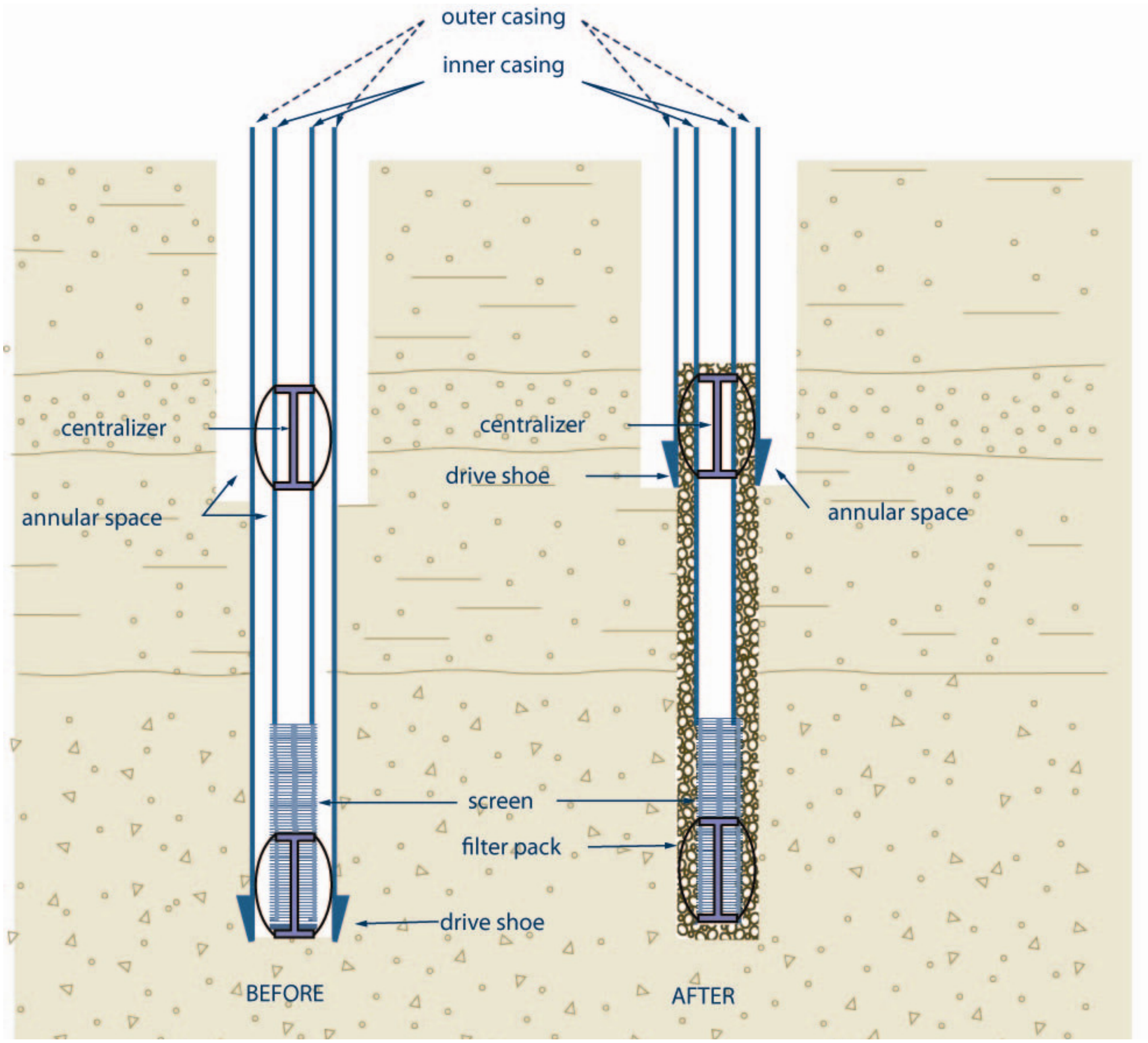


FIGURE 5-17: SINGLE STRING METHOD USING OUTER CASING

The diagram above is not to scale and is for illustrative purposes for this chapter only.

BAIL–DOWN METHOD[24]

The objective of the bail–down method is to remove sediment from below the screen to allow the well screen to settle into position below the bottom of the casing.

The general steps for the bail-down method (see Figure 5-18) are as follows:

1. The casing is installed in the well. The annular space is filled with suitable sealant (see Chapter 6: *Annular Space & Sealing*). The bottom of the casing is located slightly below where the top of well screen will be placed.
2. The bail-down shoe, heavy nipple and float shoe are assembled in the bottom of a telescopic well screen. The well screen will need a threaded bailing pipe (similar to a riser pipe) with K-packers.
3. The assembly is lifted from the bailing pipe and lowered into the well. Additional lengths of bailing pipe are added to the assembly as it is lowered into the well until the well screen reaches the bottom of the well.
4. A bailer (e.g. sand pump) is placed inside the bailing pipe. Then the formation material is bailed below the shoe fitting on the well screen. As the formation material is removed, the weight of the well screen and bail pipe causes the well screen to move downward below the bottom of the casing. It is important to carefully measure where the well screen is to be located below the well casing.
5. A weighted and tapered plug is dropped through the bailing pipe to plug the heavy nipple on the bail-down shoe. When the plug is in place, the bail pipe is unthreaded from the well screen and removed from the well. The well is then developed.
6. In other cases, the well screen is not connected to the bailing pipe. Instead, the bailing pipe is fitted with a flange or coupling large enough to press on the neoprene packer at the top of the well screen to hold it in place. To prevent the well screen from sinking below the casing, care needs to be taken as the movement of the well screen cannot be controlled during the bailing process.

[24] Sterrett, Robert J. 2007. *Ground water and Wells: Third Edition.* Johnson Screens/ a Weatherford Company. St. Paul, Minnesota.Page 470.

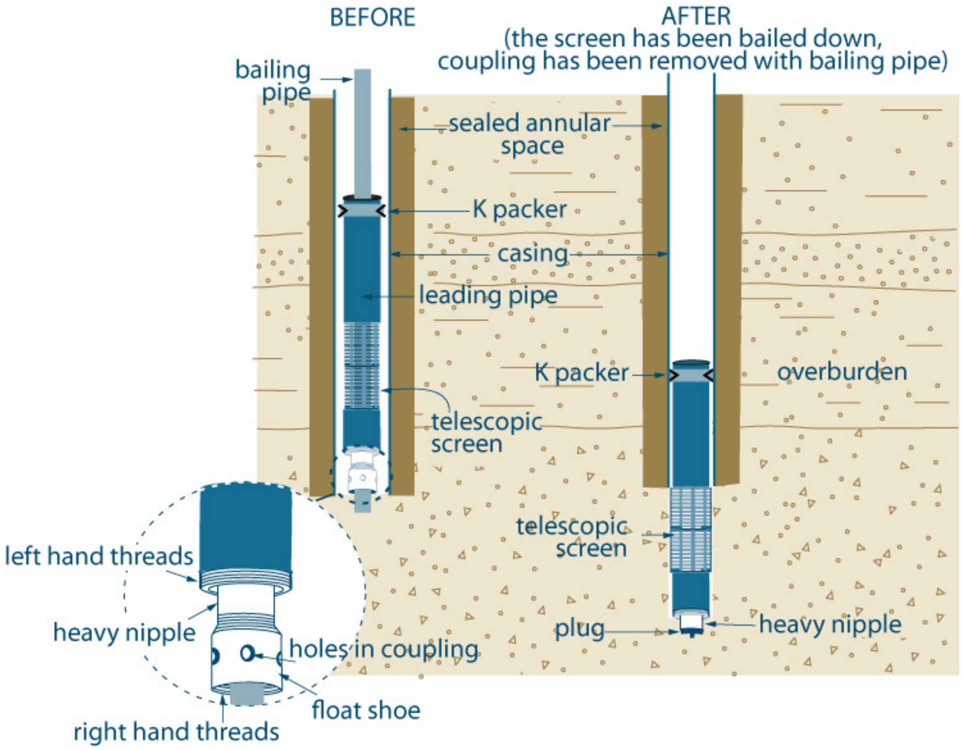


FIGURE 5-18: BAIL-DOWN METHOD OF SCREEN INSTALLATION

The diagram above is not to scale and is for illustrative purposes for this chapter only.

JETTING METHODS[25]

Jetting methods are typically used to install well screens to depths of no more than 6 m (20′) to 7.5 m (25′) below the ground surface in sand formations. There are three jetting methods used to install a well screen:

- Jetting adjacent to the casing and well screen (see Figure 5-19)
- Jetting using a wash pipe (see Figure 5-20)
- Jetting and driving using a drop line and chisel-point bit (see Figure 5-21)

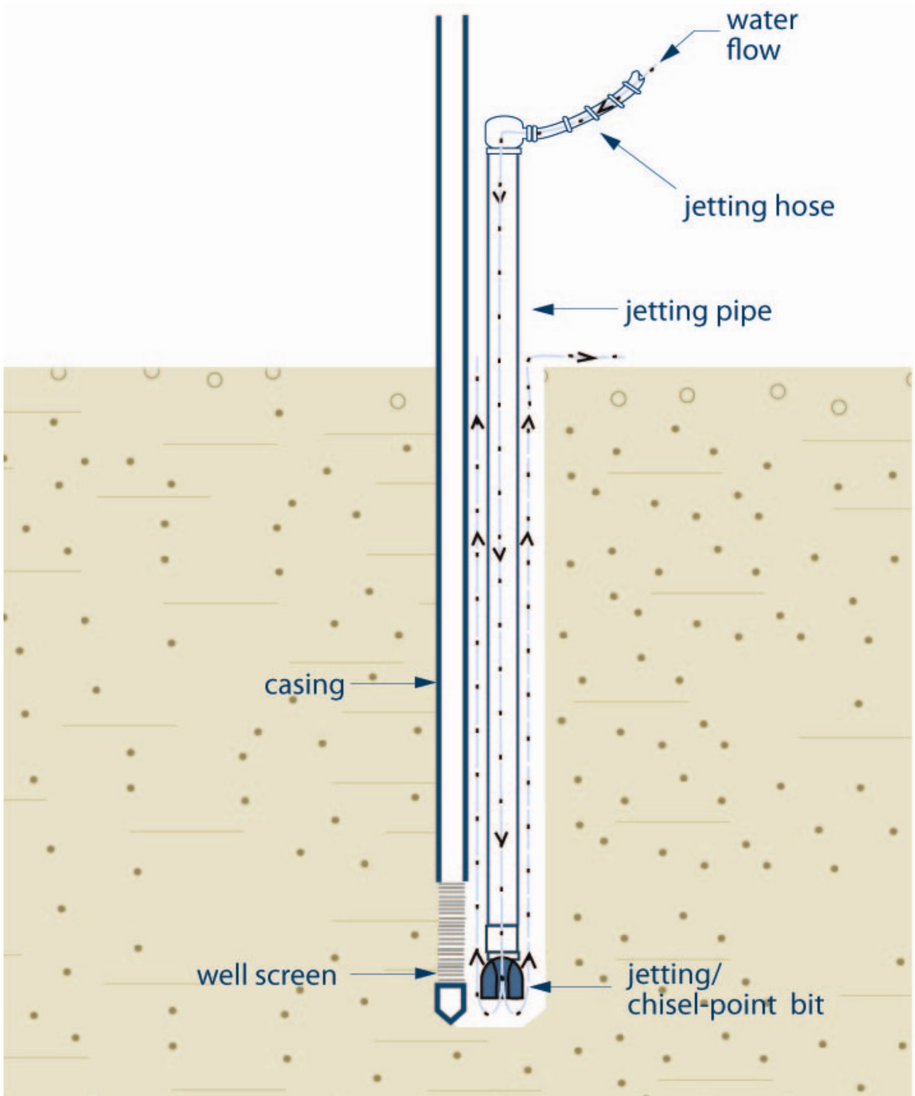
JETTING ADJACENT TO THE CASING AND WELL SCREEN

The general steps for this method (see Figure 5-19) are as follows:

1. An external pipe is placed adjacent to the casing and well screen string.
2. Water is jetted down through the pipe displacing the formation material.
3. The jetting action allows the string to sink into the sand formation to the required depth.
4. After the jetting pipe has been removed, the well then needs to be developed.

[25] Sterrett, Robert J. 2007. *Groundwater and Wells: Third Edition.* Johnson Screens/a Weatherford Company. St. Paul, Minnesota. p.478.

FIGURE 5-19: JETTING ADJACENT TO THE CASING AND WELL SCREEN



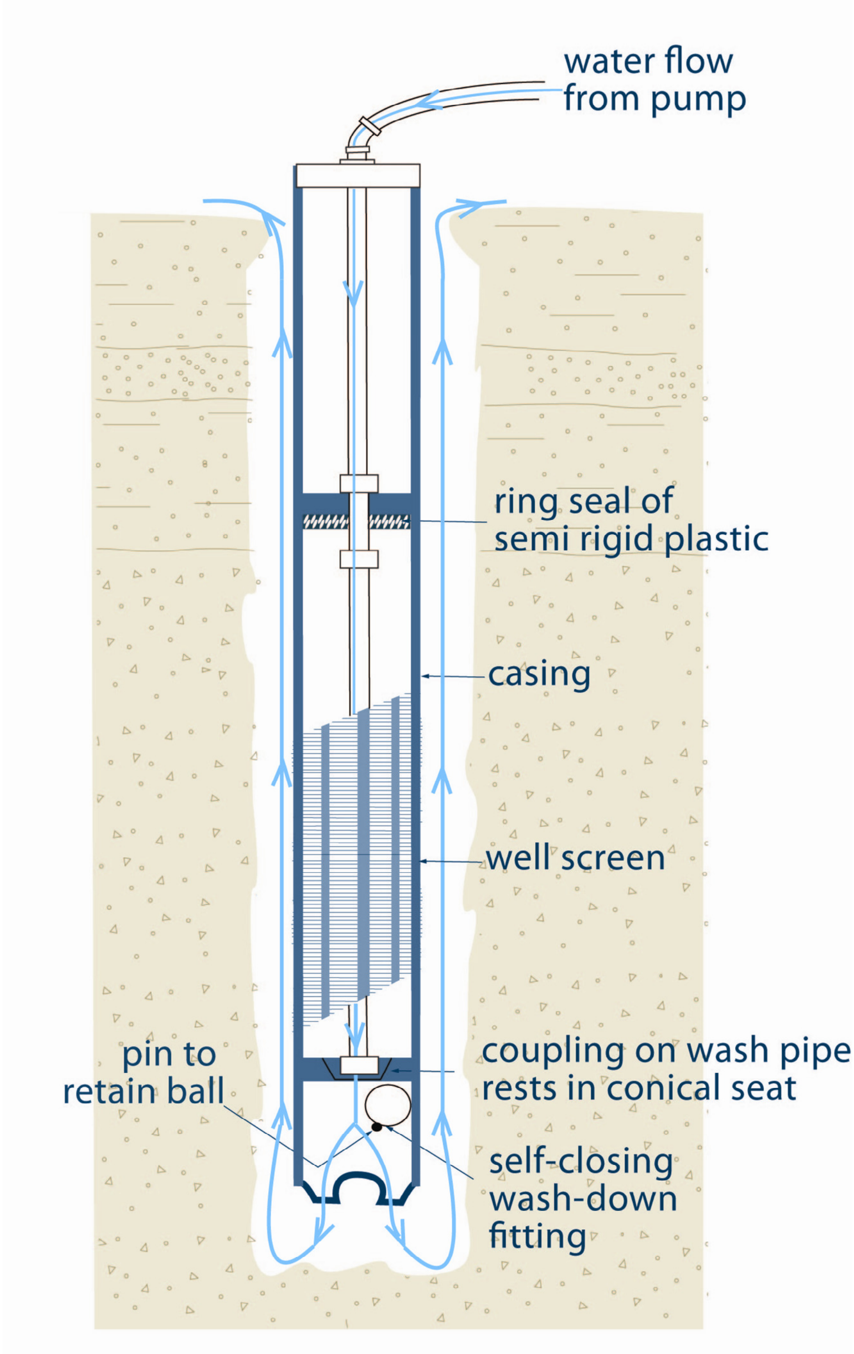
The diagram above is not to scale and is for illustrative purposes for this chapter only.

Jetting using a Wash Pipe

The general steps for this method (see Figure 5-20) are as follows:

1. A temporary wash pipe is assembled inside the well screen prior to attachment of the well screen to the bottom of the casing. The bottom of the wash pipe ends near the bottom of the well screen. The wash pipe passes up through the well screen and usually continues upward to about 30 cm (12 ″)-60 cm (24″) into the casing (see Figure 5-20). The wash pipe may extend to the surface in some shallow wells.
2. A coupling is screwed to the lower end of the wash pipe. The coupling rests in a conical seat in the self-closing wash-down fitting, which is equipped with a plastic ball closure.
3. A semi-rigid, plastic ring seal is slipped over the upper end of the wash pipe and is pushed into the top of the well screen. The purpose of this upper ring seal is to close the space around the top of the wash pipe and to direct the jetting water down into the wash pipe.
4. Water is pumped into the casing, enters the top of the wash pipe and jets down through the bottom of the self-closing wash-down fitting.
5. In sand formations, the jetting action will allow the string of casing and screen to sink into the water–bearing formation.
6. To achieve depths greater than 7.5 m (25′), it is important that drilling fluid additives be mixed with the jetting water to suspend cuttings and stabilize the hole when circulation is interrupted.
7. During this process, some of the jetting water leaks from around the bottom of the wash pipe and flows out through the well screen openings. This prevents fine sand from passing into the well screen and locking the wash pipe inside the well screen.
8. When the well screen has been set at the proper depth, the wash pipe is extracted from the well using a fishing tool.
9. After the wash pipe has been removed, the well is then developed.

FIGURE 5-20: JETTING SMALL DIAMETER WELL SCREENS INTO PLACE BY USING A WASH PIPE



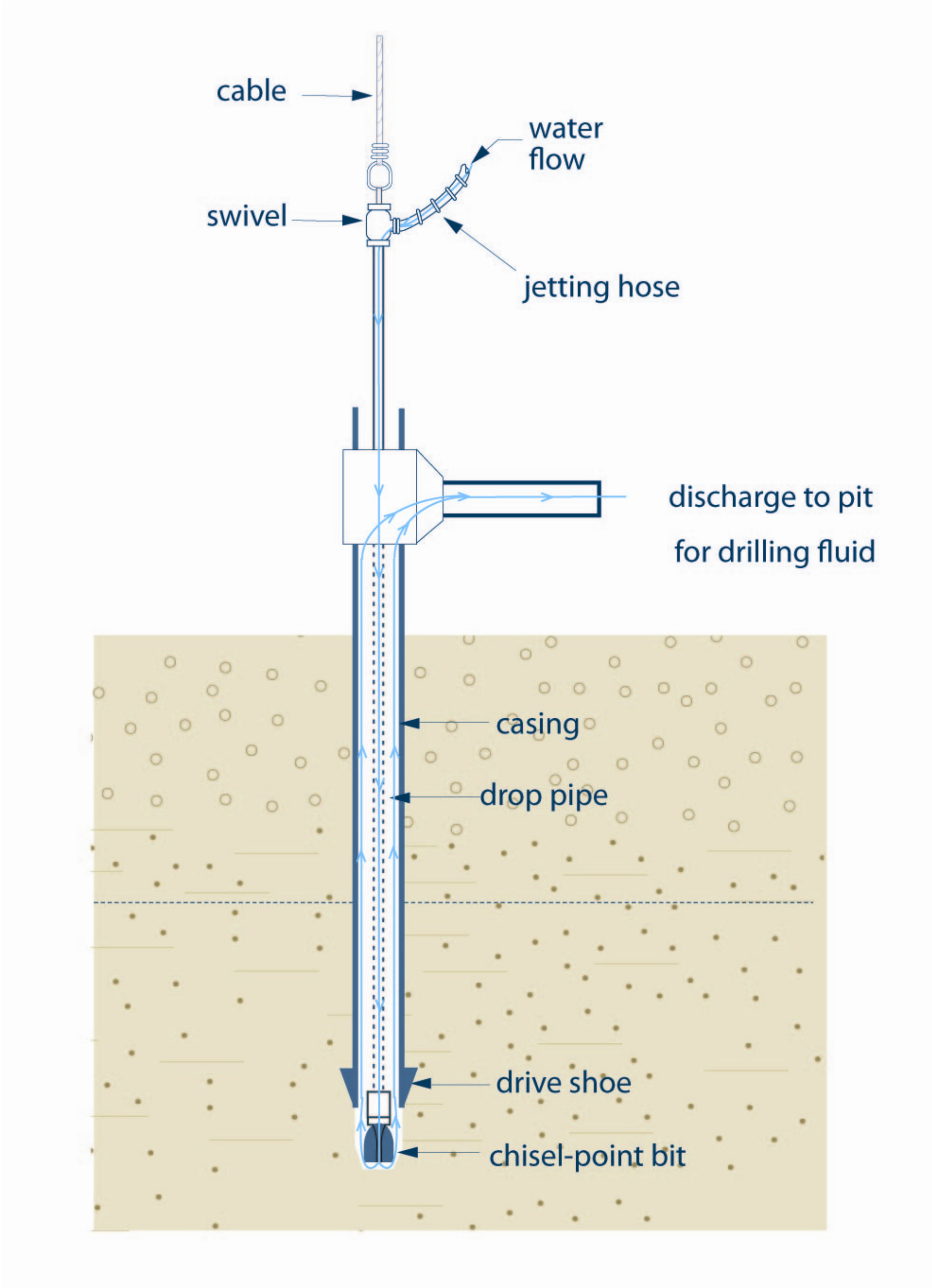
The diagram above is not to scale and is for illustrative purposes for this chapter only.

Jetting and Driving Using a Drop Line and Chisel-point Bit

The general steps for this method (see Figure 5-21) are as follows:

1. A chisel-point bit is attached to the bottom of a drop line. The drop line is placed within the well casing.
2. Water is jetted through the drop line and the jetting pipe is rotated by hand and adjusted vertically. During jetting, material is washed upward between the inside of the casing and the outside of the drop line. The drop line and bit are also intermittently driven during the process. During the process, the casing will move downward to the required depth.
3. The drop line is removed and a telescopic well screen point is inserted. Then, the well screen point is driven out the bottom of the casing. As an alternative, the well screen can be inserted into the bottom of the casing. Then the pull-back method can be used to lift the well casing and expose the well screen to the formation.

FIGURE 5-21: SCREEN INSTALLATION USING JETTING AND DRIVING SIMULTANEOUSLY



The diagram above is not to scale and is for illustrative purposes for this chapter only.

Driving Methods

Driving methods are typically used to install well screens to depths of no more than 6 m (20′) to 7.5 m (25′) below the ground surface in sand formations. There are two common driving methods used to install a well screen:

- Driving a telescopic well screen below the casing
- Driving a casing and well screen string

Driving a Telescopic Well Screen Below The Casing

1. A casing is installed within the water bearing formation.
2. A telescopic well screen point is inserted with a drive bar. The well screen is driven to expose it below the bottom of the casing while maintaining the seal with the casing.

Driving a Casing and Well Screen String

1. Using a drive bar, the casing and well screen string are driven to the water bearing formation.
2. As an alternative, hollow stem augers are placed into the ground to the water bearing formation. The casing and well screen string are placed inside the hollow stem augers and sometimes driven with the drive bar below the auger. As the augers are backed out of the hole, the annular space between the augers and the string is filled with an artificial filter pack, where necessary, and a suitable sealant.

Tips when Driving Well Screens:

The following tips should be considered when driving a well screen:

- The driving method requires additional care in sealing the joint between the driven-point well screen and casing and between other casing joints.
- The driving method requires additional care to ensure that the impact of driving does not damage the casing, well screen or joints.
- If a boulder, cobble or other large obstacle is encountered the string may be damaged or deflected. The string may have to be pulled and the hole properly abandoned (See Chapter 14: *Abandonment: When to Plug and Seal Wells* and Chapter 15: *Abandonment: How To Plug and Seal Wells*). The string will have to be relocated.
- It is important to use commercially manufactured steel driven points to penetrate the formation.

For further information see Figure 5-28: Driven Point Well on page 96 of this chapter, and the section titled “Grout Placement – Annular Space for Driven Points” in Chapter 6: *Annular Space & Sealing*.

Diagrams of Common Types of Wells

Figures 5-22 to 5-29 show cross sectional illustrations and relevant graphics for various types of wells that have been discussed in this chapter. The illustrations include the minimum size of the hole, the length of well casing, types of well screen and annular space filling materials around well screens.

All figures and diagrams are for illustrative purposes only and do not necessarily represent full compliance with other requirements found in the **Wells Regulation** (e.g. well covering during construction).

For details on the annular space filling requirements and final completion requirements not shown in Figures 5-22 to 5-29, refer to the following chapters in this manual:

- Chapter 6: *Annular Space & Sealing*
- Chapter 7: *Completing the Well's Structure*

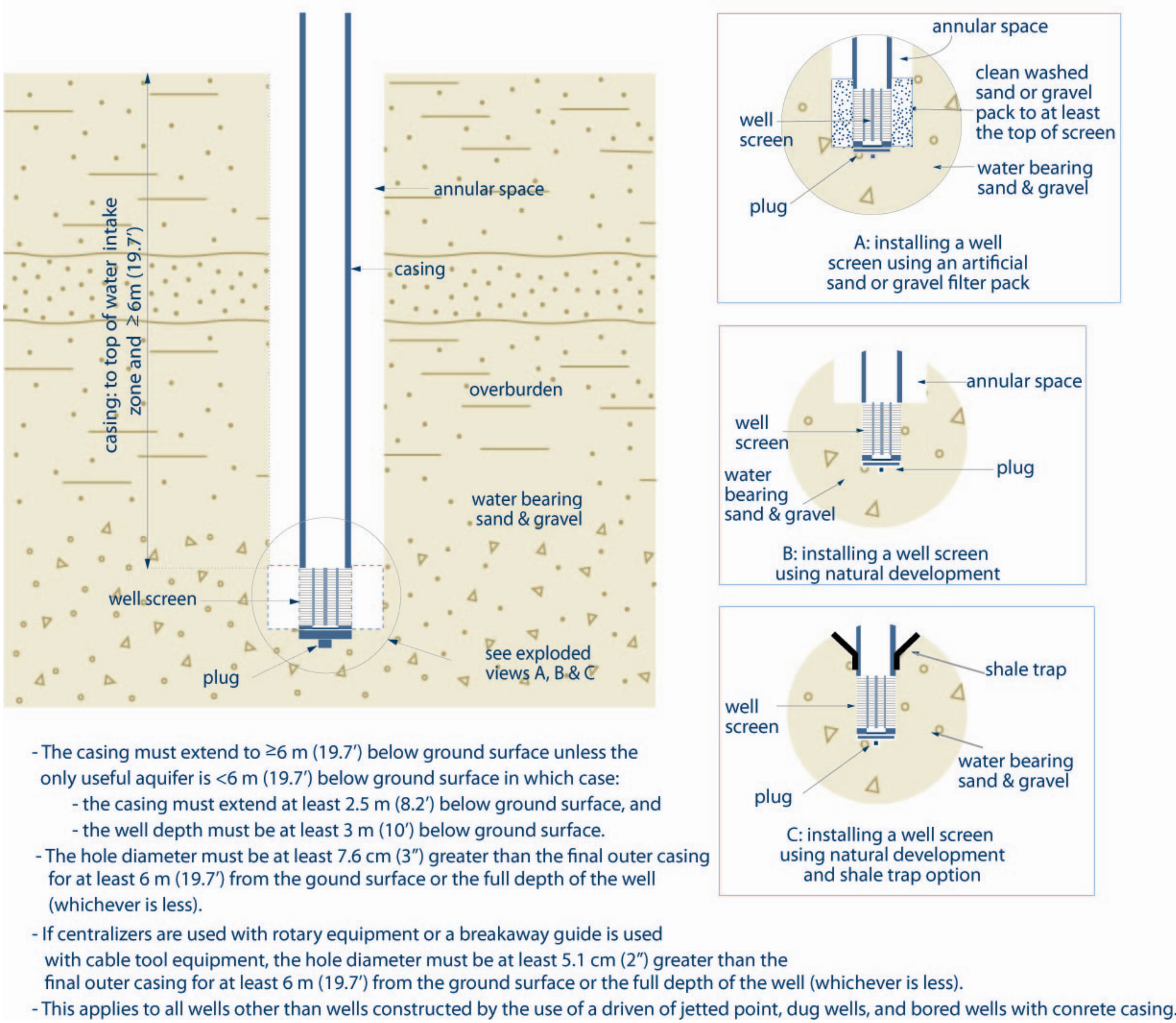
Each of the wells shown in Figures 5-22 to 5-29 may encounter conditions that require specialized design or construction. For example:

- Flowing artesian conditions
- Presence of gas
- Sucking and blowing (breathing) conditions where the well and aquifer formation are significantly affected by changes in atmospheric pressure

The illustrations and graphics may not depict every circumstance.

All figures and diagrams are for illustrative purposes only and do not necessarily represent full compliance with other requirements found in the Wells Regulation.

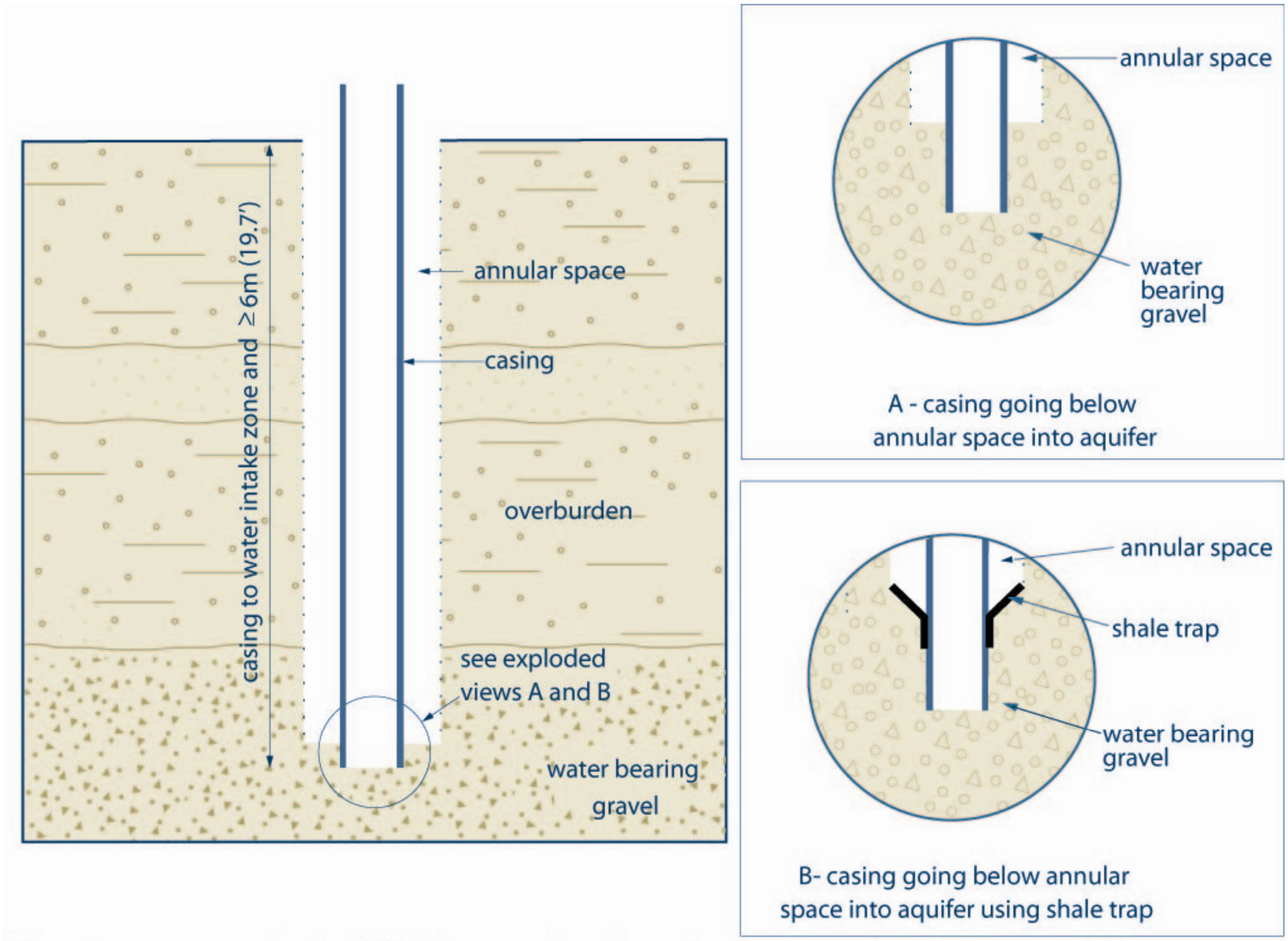
Figure 5-22: Drilled Well in Overburden – Well Screens that are Artificially Packed/Naturally Developed



Refer to Table 5-9 of this chapter for a picture of a shale trap.

The diagram above is not to scale and is for illustrative purposes for this chapter only.

FIGURE 5-23: DRILLED WELL – WITHOUT WELL SCREEN

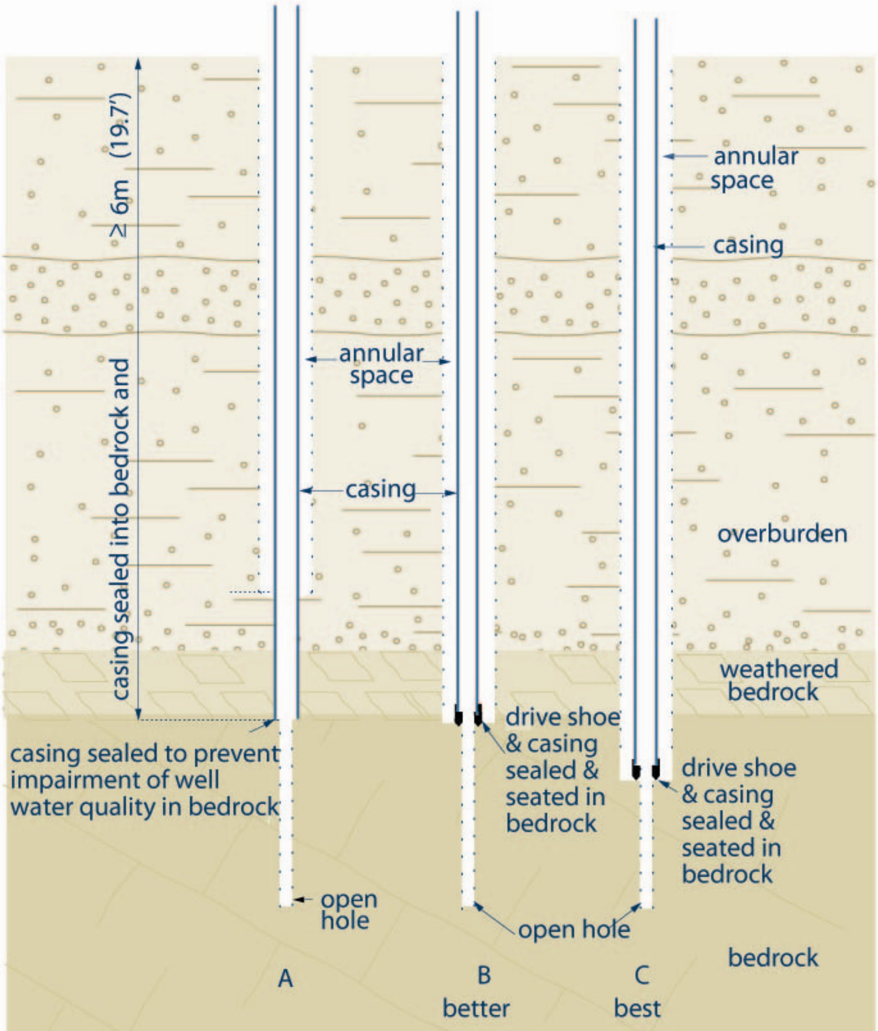


- The casing must extend ≥ 6m (19.7') below ground surface unless the only useful aquifer is < 6m (19.7') below ground surface in which case:
    - the casing must extend to at least 2.5m (8.2') below ground surface, and
    - the well depth must be ≥ 3m (10') below ground surface.
- The hole diameter must at least 7.6 cm (3") greater than the final outer casing for at least 6 m (19.7') from the gound surface or the full depth of the well (whichever is less).
- If centralizers are used with rotary equipment or a breakaway guide is used with cable tool equipment, the hole diameter must be at least 5.1 cm (2") greater than the final outer casing for at least 6 m (19.7') from the ground surface or the full depth of the well (whichever is less).
- This applies to all wells other than wells constructed by the use of a driven or jetted point, dug wells and bored wells with concrete casing.
- In this example, the casing has been driven below the bottom of the annular space.

Refer to Table 5-9 in this chapter for a picture of a shale trap.

The diagram above is not to scale and is for illustrative purposes for this chapter only.

FIGURE 5-24: EXAMPLES OF DRILLED WELLS IN BEDROCK

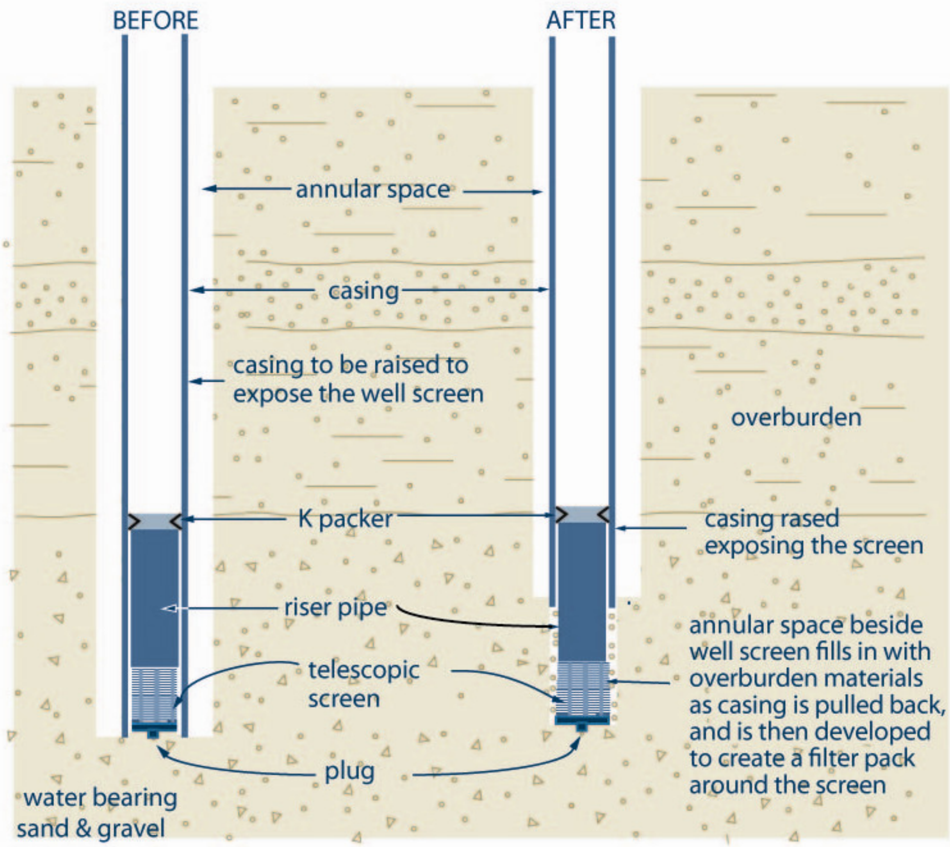


- The casing must extend to ≥6m (19.7′) below ground surface unless the only useful aquifer is < 6m (19.7′) below ground surface in which case:
  - the casing must extend at least 2.5 m (8.2′) below ground surface, and
  - the well depth must be ≥ 3 m (10′) below ground surface.
- The hole diameter must be at least 7.6 cm (3″) greater than the final outer casing for least 6 m (19.7′) from the ground surface or the full depth of the well (whichever is less).
- If centralizers are used with rotary equipment or a breakaway guide is used with cable tool equipment, the hole diameter must be at least 5.2 cm (2″) greater than the final outer casing for at least 6 m (19.7′) from the ground surface or the full depth of the well (whichever is less).
- This applies to all wells other than wells constructed by the use of a driven or jetted point, dug wells and bored wells with concrete casing.
- In the example, the casing in "A" has been driven below the bottom of the annular space.

The diagram above is not to scale and is for illustrative purposes for this chapter only.

To verify the casing is sealed into the bedrock see the "Best Management Practice – Ensuring the Casing is Sealed in the Bedrock" on page 40 of this chapter.

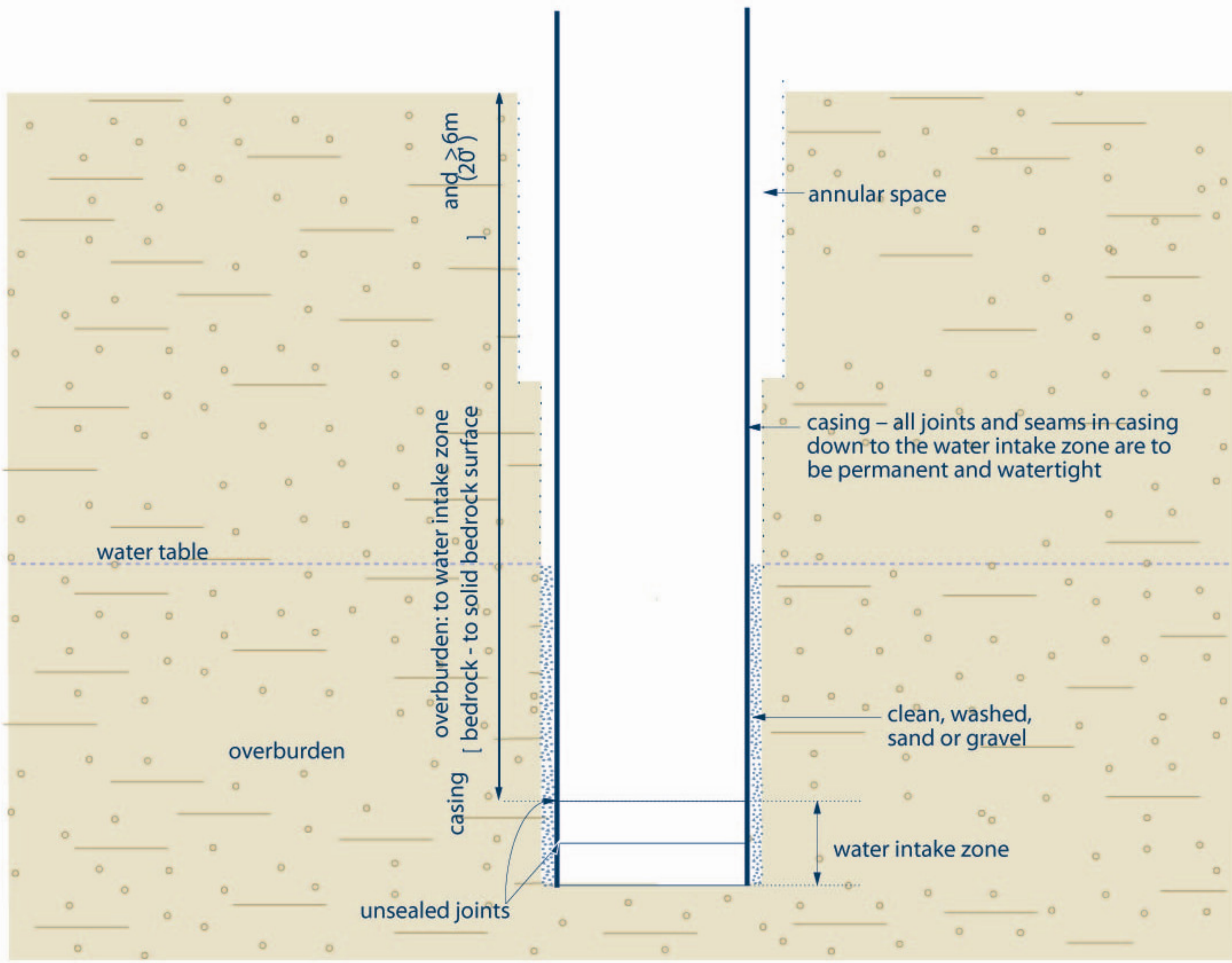
FIGURE 5-25: DRILLED WELL IN OVERBURDEN – NATURAL DEVELOPMENT, CASING PULL-BACK METHOD TO EXPOSE WELL SCREEN



- The casing must extend to ≥6m (19.7′) below ground surface unless the only useful aquifer is < 6m (19.7′) below ground surface in which case:
    - the casing must extend at least 2.5 m (8.2′) below ground surface, and
    - the well depth must be ≥ 3 m (10′) below ground surface.
- The hole diameter must be at least 7.6 cm (3″) greater than the final outer casing for least 6 m (19.7′) from the ground surface or the full depth of the well (whichever is less).
- If centralizers are used with rotary equipment or a breakaway guide is used with cable tool equipment, the hole diameter must be at least 5.2 cm (2″) greater than the final outer casing for at least 6 m (19.7′) from the ground surface or the full depth of the well (whichever is less).

The diagram above is not to scale and is for illustrative purposes for this chapter only.

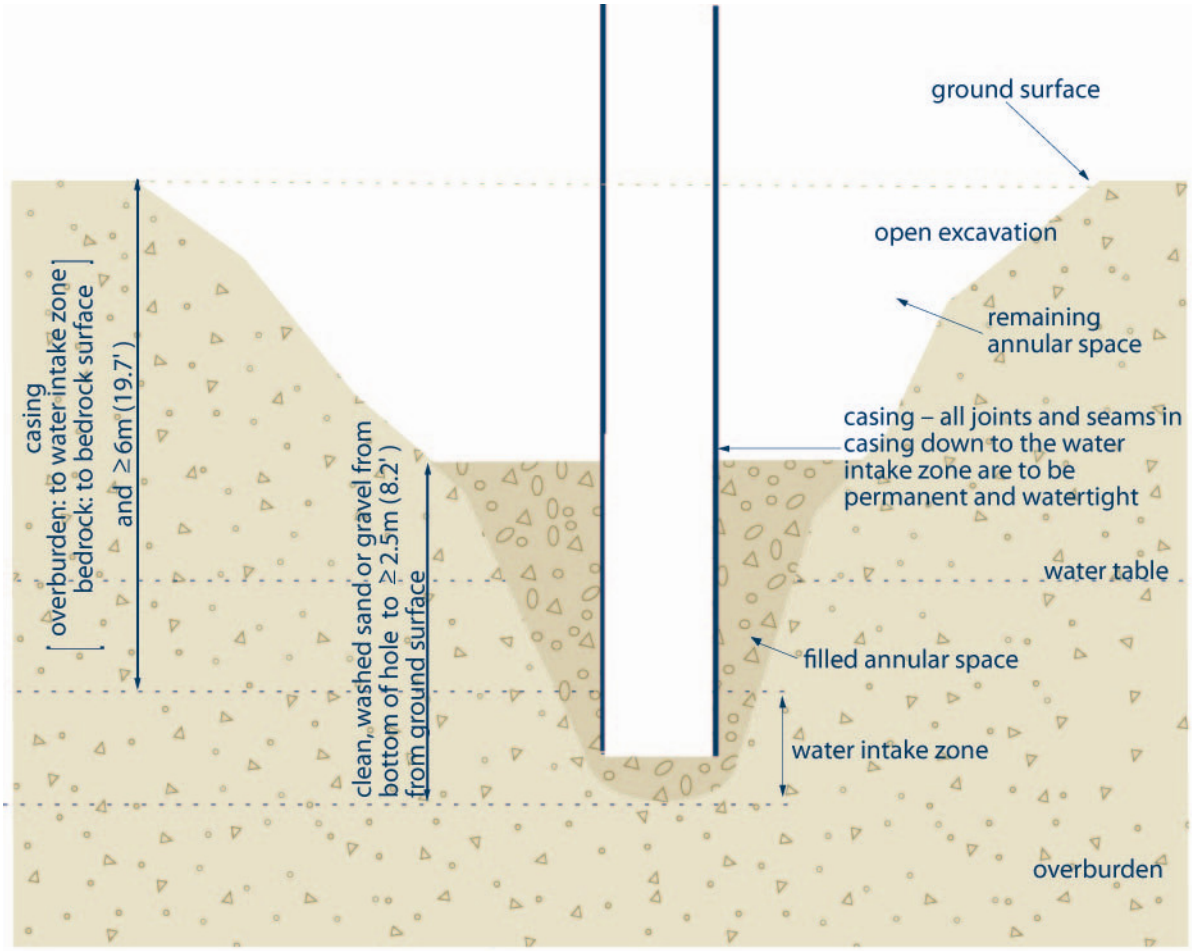
FIGURE 5-26: BORED WELL WITH CONCRETE CASING



- The casing must extend ≥6 m (19.7′) below ground surface unless the only useful aquifer is < 6m (19.7′) below ground surface in which case:
    - the casing must extend at least 2.5 m (8.2′) below ground surface, and
    - the well depth must be ≥ 3 m (10′) below ground surface.
- The hole must be at least 15.2 cm (6″) greater than the casing's outer diameter from the land surface to a depth of 2.5m (8.2′).
- The hole must be at least 7.6 cm (3″) greater than the casing's outer diameter from 2.5 m (8.2′) to at least 6 m (20′) below the ground surface.
- Sand or gravel must be installed from at least the top of the water intake zone or screen to no closer than 6 m (20′) below the land surface unless the only useful aquifer available necessitates a shallower well in which case clean, washed sand or gravel must be installed no closer than 2.5 m (8.2′) from the ground surface.

The diagram above is not to scale and is for illustrative purposes for this chapter only.

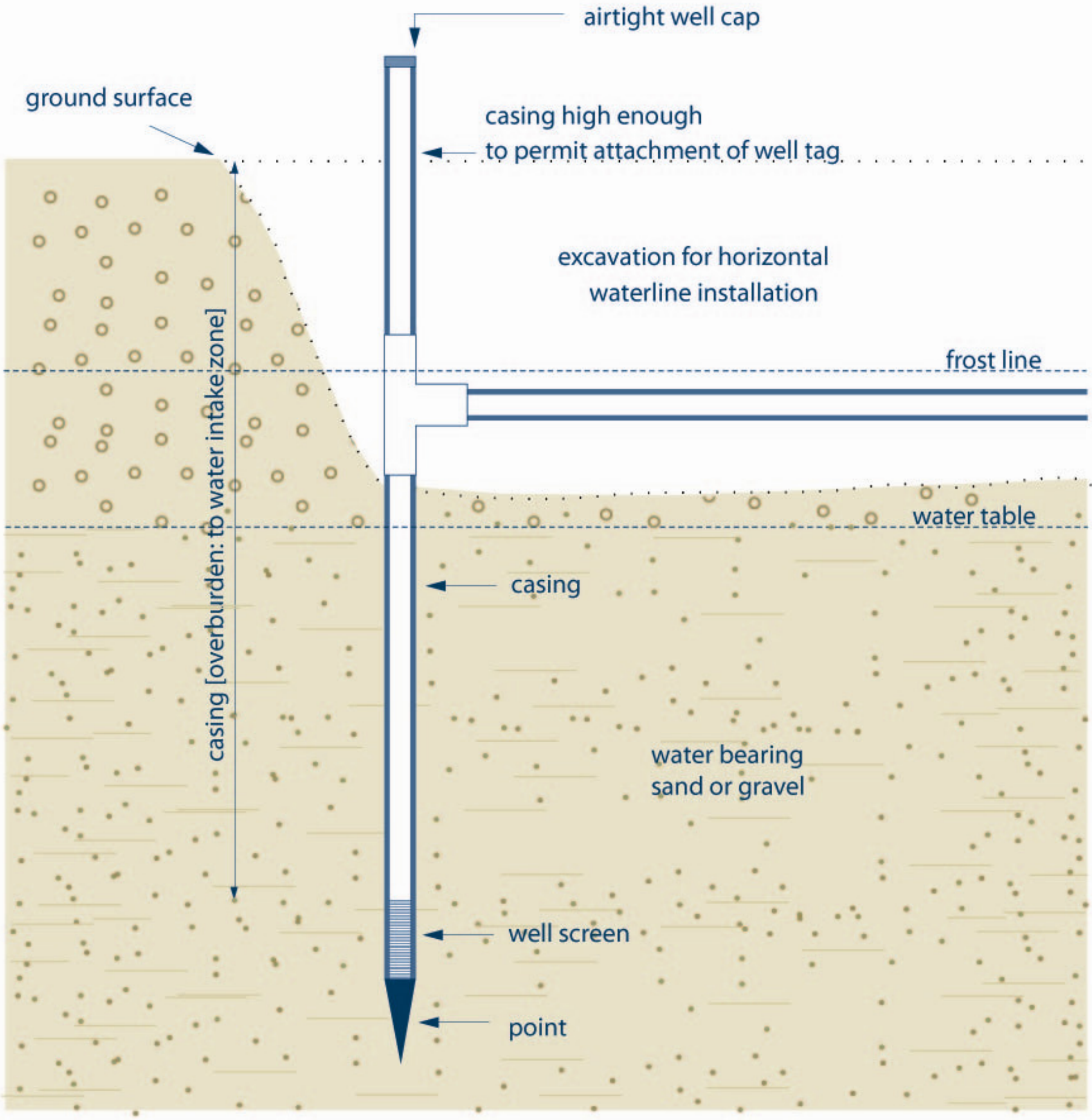
FIGURE 5-27: DUG WELL



- The casing must extend ≥6 m (19.7') below ground surface unless the only useful aquifer is < 6 m (20') below ground surface in which case:
    - the casing must extend at least 2.5 m (8.2') below ground surface, and
    - the well depth must be ≥ 3 m (10') below ground surface.
- All concrete tiles with joints that are not sealed, and are installed to filter out particulate matter are considered well screen (water intake zone).
- Sand or gravel can be replaced with native material (soil) that was excavated from the hole, if the well is not constructed in a contaminated area and the horizons of soil are excavated separately, stored separately, kept free from contamination and backfilled in the same relative positions that they originally occupied.

The diagram above is not to scale and is for illustrative purposes for this chapter only.

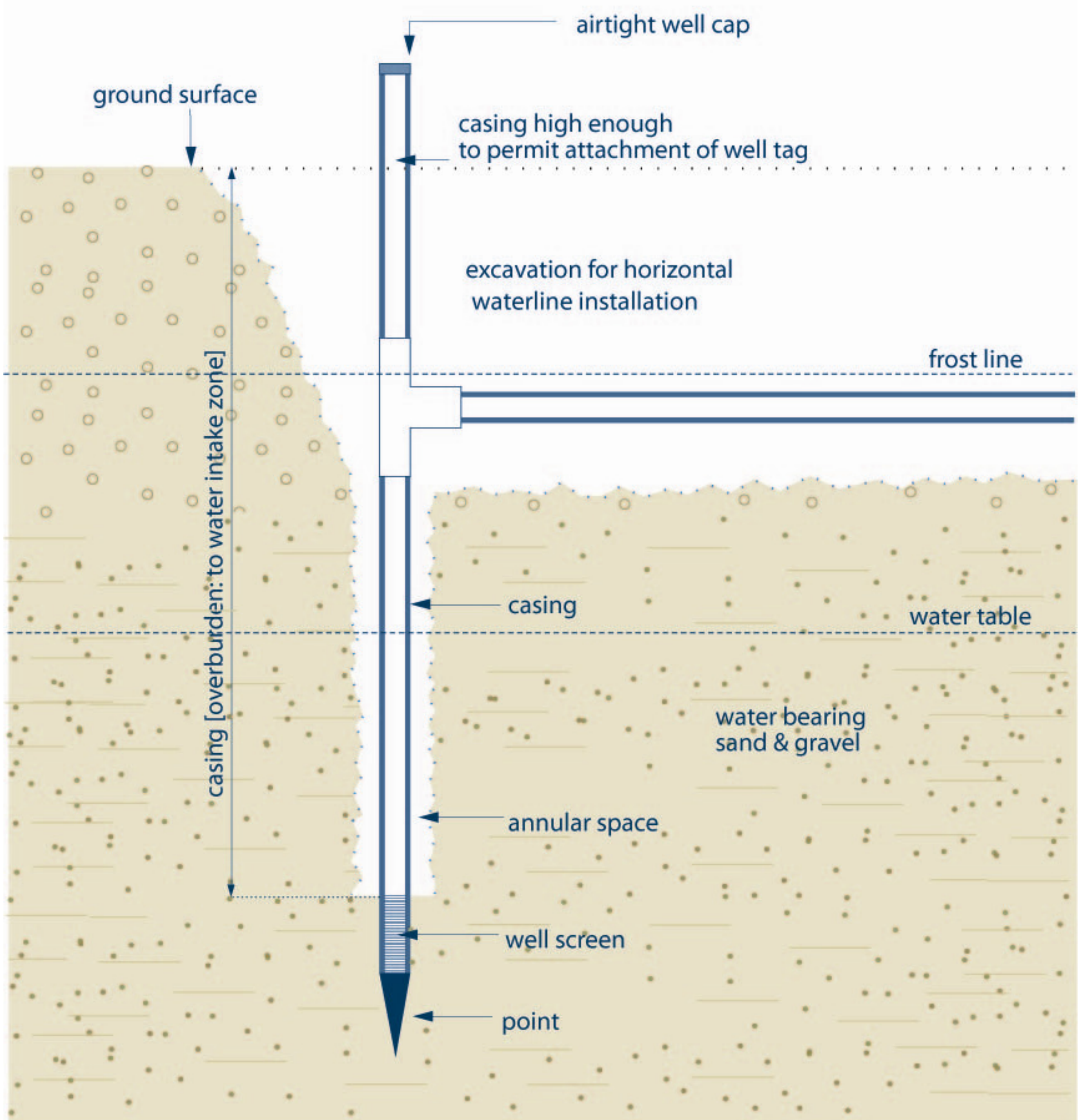
FIGURE 5-28: DRIVEN POINT WELL



- The casing must extend ≥6 m (19.7′) below ground surface unless the only useful aquifer is < 6m (19.7′) below ground surface in which case:
  - the casing must extend at least 2.5 m (8.2′) below ground surface, and
  - the well depth must be ≥3 m (10′) below ground surface.

The diagram above is not to scale and is for illustrative purposes for this chapter only.

FIGURE 5-29: JETTED WELL



The casing must extend ≥ 6m (19.7′) below ground surface unless the only useful aquifer is < 6m below ground surface in which case:

- the casing must extend at least 2.5m (8.2′) below ground surface, and
- the well depth must be ≥ 3m (10′) below ground surface.

The diagram above is not to scale and is for illustrative purposes for this chapter only.

6. Annular Space & Sealing

Chapter Table of Contents

Chapter Figures

Chapter Tables

Chapter Description

This chapter covers the construction process involved in sealing the well casing into the hole to ensure that there is no movement of water or other materials along the annular space as required by the **Wells Regulation**.

Regulatory Requirements – Annular Space & Sealing of a New Well

Relevant Sections – The Wells Regulation

Casing – Subsections 13(12)* and *13(20)

Annular Space – Sections 14 and 14.1* to *14.6

The Requirements – Plainly Stated

The Wells Regulation requires the following regarding the Annular Space and Seal for new well construction:

Sealing Casing in Bedrock for New Drilled Wells

- If the aquifer is located in a weathered bedrock zone, the new drilled well must be cased to the bedrock, but the casing is not required to be sealed into the bedrock.
- If the aquifer is located in a bedrock zone that is not weathered, the casing of a new drilled well must be sealed into the bedrock with suitable sealant to prevent impairment of the quality of the groundwater and the water in the well.

Sealing Annular Space between Casings

- The annular space between casings of different diameters must be sealed with suitable sealant to prevent the entry of surface water or other foreign materials into the well.

Subsurface Movement for New Well Construction

- Any annular space, other than the annular space surrounding the well screen, must be sealed to prevent any movement of water, natural gas, contaminants or other material between subsurface formations or between subsurface formations and the ground surface by means of the annular space.

Sealing Annular Space for New Wells

- Table 6-1on page 10 of this chapter for a summary of the requirements outlined in the **Wells Regulation** regarding the annular space and sealing for new well construction other than jetted wells or wells constructed by use of a driven point.

New Wells Constructed by Use of a Driven Point

- A person constructing a well by use of a driven point must ensure that any annular space is filled to the ground surface using a method and material approved by the Director (see "Grout Placement – When an Annular Space is Created by Use of a Driven Point" on page 44 of this chapter).

Definitions for sealant, watertight, tremie pipe and other relevant terms are stated in Chapter 2: *Definitions & Clarifications*.

See Figures 6-6 to 6-13 (pages 19 to 26 of this chapter) for illustrations of the sealing requirements described in Table 6-1 for most common wells. The requirement for jetted wells is outlined in the Plainly Stated, "Subsurface Movement for New Well Construction" section above. For wells constructed by use of a driven point, see "Grout Placement – When an Annular Space is Created by Use of a Driven Point" on page 44 of this chapter.

Table 6-1: Annular Space and Sealing Requirements

New Bored Wells With Concrete Casing and Dug (or Excavated) Wells			
	Bored Well with Concrete Casing ≥ 6 m (19.7′) deep	**Bored Well with Concrete Casing < 6 m (19.7′) deep**	**Dug (or Excavated) Well**
Minimum Diameter of Hole Greater Than Outer Casing Diameter to Create Annular Space	From ground surface to ≥2.5 m (8.2′) below ground surface Minimum Diameter is ≥15.2 cm (6″)	From ground surface to ≥ 2.5 m (8.2′) below ground surface Minimum Diameter is ≥ 15.2 cm (6″)	None
	From ≥2.5 m (8.2′) below the ground surface Minimum Diameter is ≥7.6 cm (3″)	From ≥2.5 m (8.2′) below the ground surface Minimum Diameter is ≥ 7.6 cm (3″)	
Minimum Depth of Annular Space below Ground Surface	≥6 m (19.7′)	Bottom of well	None
Bottom of Filter Pack Material around Well Screen if present	Bottom of well screen	Bottom of well screen	Bottom of well
Type of Annular Filter Pack, Granular or Native Material	Clean, washed gravel or sand Deposited only after placement of well screen and casing Only applies if well screen is present	Clean, washed gravel or sand Deposited only after placement of well screen and casing Only applies if well screen is present	Clean, washed gravel, Clean, washed sand or Native materials (soil) excavated from the well Native materials (soil) can only be used if they are not from a contaminated area and the major horizons of soil are excavated and stored separately, kept free of contamination and then backfilled within the annular space in the same relative position that the horizon originally occupied.
Maximum Top of Annular Filter Pack Material around Well Screen and Well Casing	At least the top of well screen but no closer to ground surface than 6 m (19.7′) below ground surface Only applies where well screen is present	At least the top of well screen but no closer to ground surface than 2.5 m (8.2′) below ground surface Only applies where well screen is present	No closer to ground surface than 2.5 m (8.2′) below ground surface.

New Bored Wells With Concrete Casing and Dug (or Excavated) Wells			
	Bored Well with Concrete Casing ≥ 6 m (19.7′) deep	**Bored Well with Concrete Casing < 6 m (19.7′) deep**	**Dug (or Excavated) Well**
Annular Seal Material around Casing in Remaining Open Annular Space from Filter Pack, Granular or Native Material to ≥ 2.5 m (8.2′) below Ground Surface	Suitable sealant placed using tremie pipe with bottom end of pipe immersed in rising accumulation of sealant If no well screen is used, suitable sealant must be used to fill the space from the bottom of the well up to this depth	Suitable sealant placed using tremie pipe with bottom end of pipe immersed in rising accumulation of sealant If no well screen is used, suitable sealant must be used to fill the space from the bottom of the well up to this depth	Suitable sealant that has structural strength to support weight of persons and vehicles
Annular Seal Material around Casing from ≥ 2.5 m (8.2′) below Ground Surface to Ground Surface	Bentonite granules, pellets or chips that have been screened to manufacturer's specifications and have a diameter range between 6 to 20 mm (0.23 to 0.8″) are placed immediately above the suitable sealant	Bentonite granules, pellets or chips that have been screened to manufacturer's specifications and have a diameter range between 6 to 20 mm (0.23 to 0.8″) are placed immediately above the suitable sealant	Suitable sealant that has structural strength to support weight of persons and vehicles
Where Cement is used in Suitable Sealant Mixture	Allow cement to cure to manufacturer's specifications or for 12 hours whichever is longer. If cement mixture settles, the suitable sealant shall be topped up to the original level	Allow cement to cure to manufacturer's specifications or for 12 hours whichever is longer. If cement mixture settles, the suitable sealant shall be topped up to the original level	Allow cement to cure to manufacturer's specifications or for 12 hours whichever is longer. If cement mixture settles, the suitable sealant shall be topped up to the original level

New Drilled Wells, Other Wells* and Well Pits (Table 6-1 continued)			
	Drilled Well or any other Well ≥6 m (19.7′) deep that is not listed on Table 6-1 (except jetted and wells constructed by the use of a driven point)	**Drilled Well or any other Well < 6 m (19.7′)deep that is not listed on Table 6-1 (except jetted and wells constructed by the use of a driven point)**	**New Well Pit (see Chapter 9: *Equipment Installation*)**
Minimum Diameter of Hole Greater Than Outer Casing Diameter to Create Annular Space	Minimum Diameter is ≥7.6 cm (3″)	Minimum Diameter is ≥7.6 cm (3″)	≥7.6 cm (3″)
	Minimum Diameter is ≥ 5.1 cm (2″) If centralizers are attached to casing > 6m (19.7’) below the ground surface using rotary drilling equipment OR If a breakaway guide is attached 2m (6.3’) above the bottom of any casing using cable tool equipment	Minimum Diameter is ≥5.1 cm (2″) If a breakaway guide is attached 2m (6.3’) above the bottom of any casing using cable tool equipment	
Minimum Depth of Annular Space below Ground Surface	≥ 6 m (19.7′)	Where no well screen is installed: • bottom of well. If well screen installed: • bottom of well screen, and • top of well screen must not be closer to ground surface than 2.5 m (8.2′).	Bottom of well pit
Bottom of Filter Pack Material around Well Screen if present	Bottom of well	Bottom of well	None
Type of Annular Filter Pack Material around Well Screen	Clean, washed gravel or sand Placed during or after placement of well screen and casing	Clean, washed gravel or sand Placed during or after placement of well screen and casing	None

New Drilled Wells, Other Wells* and Well Pits (Table 6-1 continued)			
	Drilled Well or any other Well ≥6 m (19.7′) deep that is not listed on Table 6-1 (except jetted and wells constructed by the use of a driven point)	**Drilled Well or any other Well < 6 m (19.7′)deep that is not listed on Table 6-1 (except jetted and wells constructed by the use of a driven point)**	**New Well Pit (see Chapter 9: *Equipment Installation*)**
	Clean, washed gravel or sand placed during or after placement of well screen and casing OR Clean, washed gravel or sand developed after placement of suitable sealant using surging to remove fine grained soils	Clean, washed gravel or sand placed during or after placement of well screen and casing OR Clean, washed gravel or sand developed after placement of suitable sealant using surging to remove fine grained soils	None
Maximum Top of Annular Filter Pack Material around Well Screen and Well Casing	At least the top of well screen but no closer to ground surface than 6 m (19.7′) Only applies where well screen is present	At least the top of well screen but no closer to ground surface than 2.5 m (8.2′) Only applies where well screen is present	None
Annular Seal Material around Casing in remaining Open Annular Space	Suitable sealant placed using tremie pipe with bottom end of pipe immersed in rising accumulation of sealant. If minimum hole diameter is ≥ 5.1 cm (2″) more than outer casing diameter, sealant particle size must not be subject to bridging. If no well screen is used, suitable sealant must be used to fill the space from the bottom of the annular space adjacent to the casing up to ground surface.	Suitable sealant placed using tremie pipe with bottom end of pipe immersed in rising accumulation of sealant. If minimum hole diameter is ≥ 5.1 cm (2″) more than outer casing diameter, sealant particle size must not be subject to bridging. If no well screen is used, suitable sealant must be used to fill the space from the bottom of the annular space adjacent to the casing up to ground surface.	Suitable sealant with structural strength to support weight of persons and vehicles

New Drilled Wells, Other Wells* and Well Pits (Table 6-1 continued)			
	Drilled Well or any other Well ≥6 m (19.7′) deep that is not listed on Table 6-1 (except jetted and wells constructed by the use of a driven point)	**Drilled Well or any other Well < 6 m (19.7′)deep that is not listed on Table 6-1 (except jetted and wells constructed by the use of a driven point)**	**New Well Pit (see Chapter 9: *Equipment Installation*)**
Where Cement is used in Suitable Sealant Mixture	Allow cement to cure to manufacturer's specifications or for 12 hours whichever is longer. If cement mixture settles, the suitable sealant shall be topped up to the original level	Allow cement to cure to manufacturer's specifications or for 12 hours whichever is longer. If cement mixture settles, the suitable sealant shall be topped up to the original level	Allow cement to cure to manufacturer's specifications or for 12 hours whichever is longer. If cement mixture settles, the suitable sealant shall be topped up to the original level

"Other wells" excludes dug wells, bored wells with concrete casing, jetted wells or wells that are constructed by the use of a driven point.

- When mixing, handling or placing any grout material (wet and dry) always follow manufacturer's specifications and recommended procedures. Consult the Material Safety Data Sheet (MSDS) for additional information on safe handling and usage.

Double Walled Casing (or annular space between inner and outer casings):

In some cases, multiple casings of different diameters are installed in wells to reach a water producing zone. This type of installation is common in municipal wells, some flowing wells and other large water taking wells. For example, the initial 20 metres (65′) of the hole may have a 40 cm (16″) diameter casing. The next 20 m (65′) of the hole may have a 30 cm (12″) diameter casing. The overlapping zone between the inner and outer casings is considered an annular space and must be sealed, for new wells, as follows:

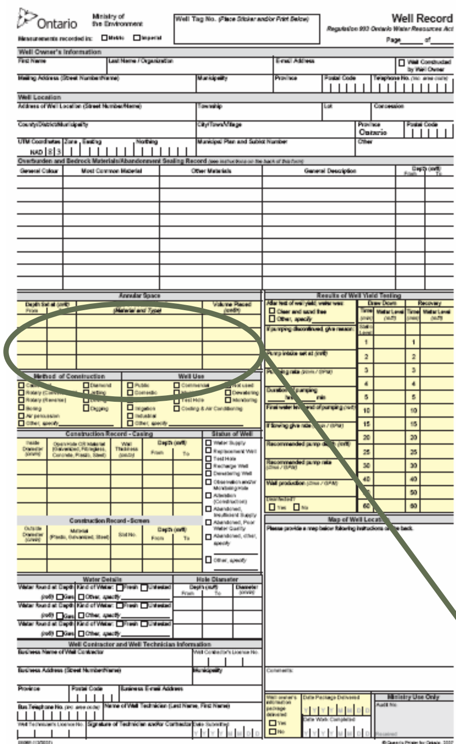
- All construction and sealing requirements for the corresponding well construction method in Table 6-1 apply with necessary modifications to the well's annular space on the outside of the outer casing.
- Except for a well pit, all construction and sealing requirements for the corresponding well construction method in Table 6-1 apply with necessary modifications to the well's annular space between the casings. This requirement does not apply if groundwater is not leaking into the annular space between the casings.
- In all cases, the annular space between casings of different diameters must be sealed with suitable sealant to prevent the entry of surface water and other foreign materials into the well.

Annular Space Constructed by any Method:

Any annular space, other than annular space surrounding the well screen, must be sealed to prevent any movement of water, natural gas, contaminants or other material between subsurface formations or between subsurface formations and the ground surface.

Well Record – Relevant Sections

Figure 6-1: Well Record – Relevant Sections – Annular Space



Annular Space

- Record 'Depth Set at' relative to the ground surface.
- Record 'Depth Set at' and 'Volume Placed' in the measurement units indicated at the top of the well record (metric or Imperial).
- Calculate 'Volume Placed' using the information found in "Calculating Amount of Materials Required" on page 32 of this chapter.

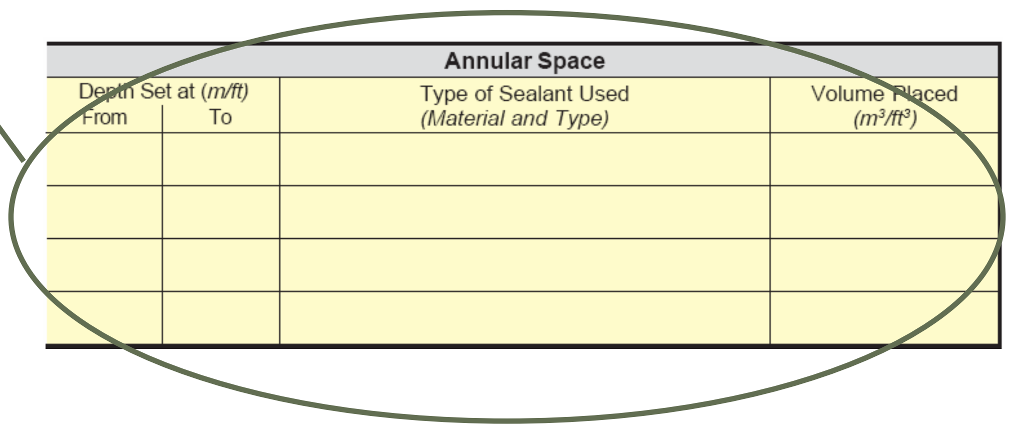
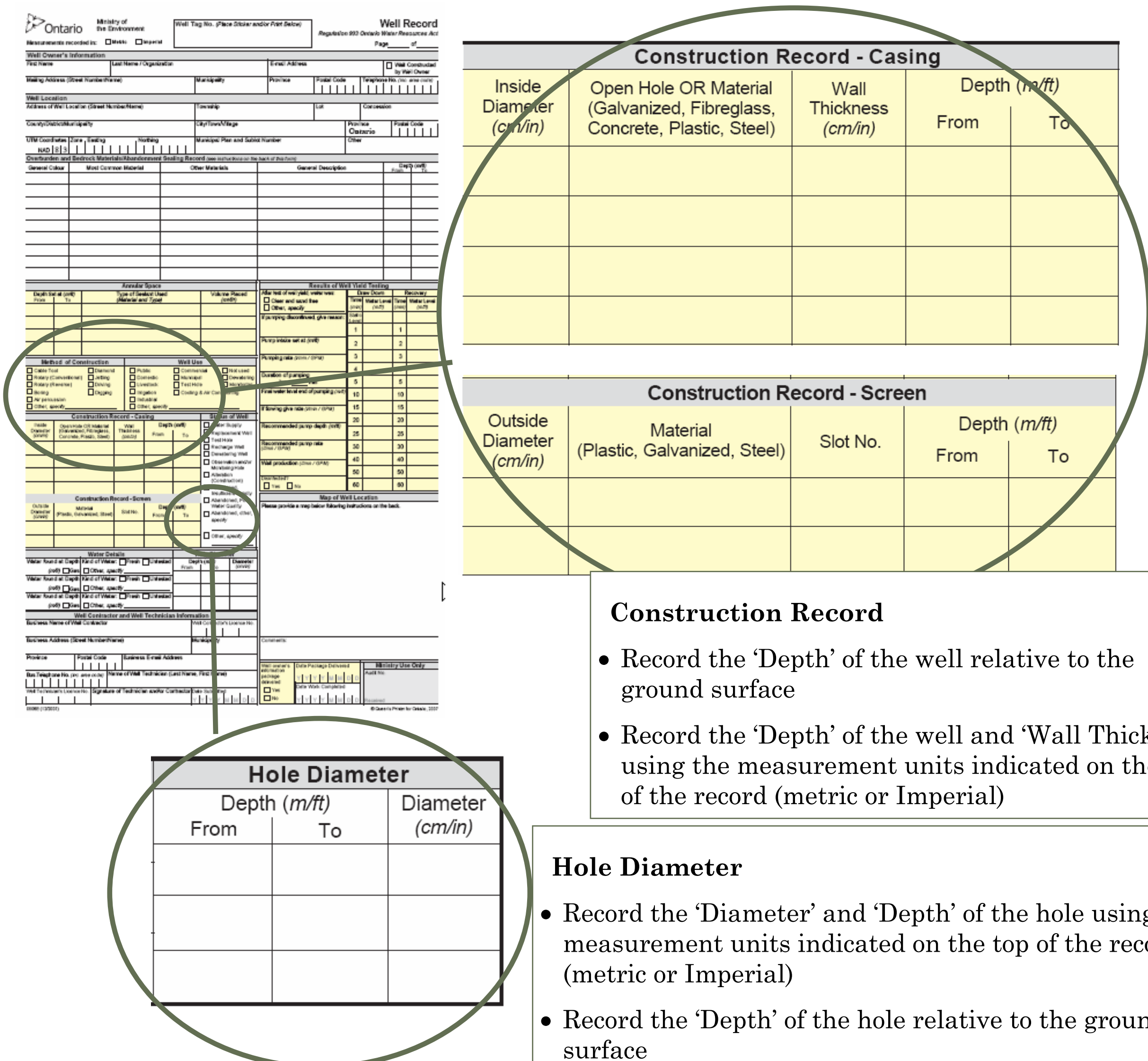


FIGURE 6-2: WELL RECORD – RELEVANT SECTIONS – CONSTRUCTION RECORD

Figure 6-2 shows where the details regarding the construction of the hole and casing the well are to be recorded on the well record.



Construction Record

- Record the 'Depth' of the well relative to the ground surface
- Record the 'Depth' of the well and 'Wall Thickness' using the measurement units indicated on the top of the record (metric or Imperial)

Hole Diameter

- Record the 'Diameter' and 'Depth' of the hole using the measurement units indicated on the top of the record (metric or Imperial)
- Record the 'Depth' of the hole relative to the ground surface

Best Management Practice – Report use of Centralizers

The use of centralizers or breakaway guides and where they are located in the well should be reported on the well record in the "Overburden and Bedrock Materials/Abandonment Sealing Record" section of the Well Record. See Chapter 13: *Well Records, Documentation, Reporting & Tagging* for the complete well record.

Key Concepts

The Annular Space

The hole must be constructed to ensure there is a minimum annular space created between the well casing and the side of the well, and in some cases between the well screen and the side of the well. Annular spaces need to be large enough to ensure suitable sealant (grout) can fill and adhere around the entire outer well casing to prevent surface water, groundwater, natural gas and other foreign materials from migrating along the outside of the well casing.

Best Management Practice – Annular Space Diameter

It is important to create hole diameters of sufficient width to ensure sealant will fill and adhere to the well's casing and formation. In most subsurface conditions, the hole diameter should be 102 mm (4″) to 203 mm (8″) larger than the outer finished casing diameter because it facilitates the use of tremie pipes and the placement of the sealant, and possibly the filter pack, in the annular space.

See Chapter 5: *Constructing & Casing the Well* for information on creating the hole.

Purpose of the Seal

Any annular space, including the space between overlapping casings within the well, must be properly filled with a suitable sealant (or grout) to:

1. Isolate a discrete zone
2. Prevent migration of surface water and other foreign materials into the well and aquifers
3. Prevent migration of groundwater between water bearing formations and subsurface formations
4. Prevent migration of groundwater between water bearing formations and the ground surface
5. Prevent aquifer depressurization by stopping the upward migration of water along the casing
6. Prevent gas migration

Examples of Improperly Sealed Annular Spaces

Figure 6-3: Visible Open Annular Space Adjacent to Drilled Well Casing

Figure 6-3 shows an annular space that goes from ground surface to the bottom of the casing (not shown) and allows for migration of surface water and other foreign materials into the well and aquifer.

Figure 6-4: Visible Open and Large Annular Space Around Drilled Well

In Figure 6-4, the annular space extends from ground surface, through an upper aquifer and to the bottom of the casing (not shown). The annular space allows for migration of surface water and other foreign materials into the well and aquifers. It also allows contaminated groundwater from this upper aquifer to mix with and impair the waters of a lower aquifer. In this case, the open space also creates a physical hazard.

This photograph also shows the use of casings with differing diameters that appear to be improperly joined.

Figure 6-5: Visible Open Annular Space Below Pitless Adapter and Horizontal Waterline to the Bottom of the Casing

Figure 6-5 shows a visible open space (i.e. annular space) below the pitless adapter and horizontal waterline. The open space extends to the bottom of the casing (not shown in photograph). Above the waterline, the person constructing the well installed a bluish grey coloured bentonite grout in the annular space from above the pitless adapter to the ground surface (see circled area). Thus, no one knew the annular space was improperly filled (or left open) below the pitless adapter until the exterior of the well was excavated. The open space acts as a direct pathway for foreign materials to enter and impair groundwater resources.

REQUIREMENTS FOR SEALING VARIOUS TYPES OF WELLS

Figures 6-6 to 6-13 show cross-sectional illustrations and relevant graphics for various types of wells including length of well casing, types of well screen, minimum hole size, and annular space filling products around well screens and suitable sealant in the annular space around the well casing.

All figures and diagrams are for illustrative purposes only and do not necessarily represent full compliance with other requirements found in the **Wells Regulation** (e.g. Well covering during construction).

During and after construction the person constructing the well must ensure surface drainage is such that water will not collect or pond in the vicinity of the well.

For details on the hole, casing and final completion requirements not shown in Figures 6-6 to 6-13 (pages 19 to 26 of this chapter) refer to the following chapters in this manual:

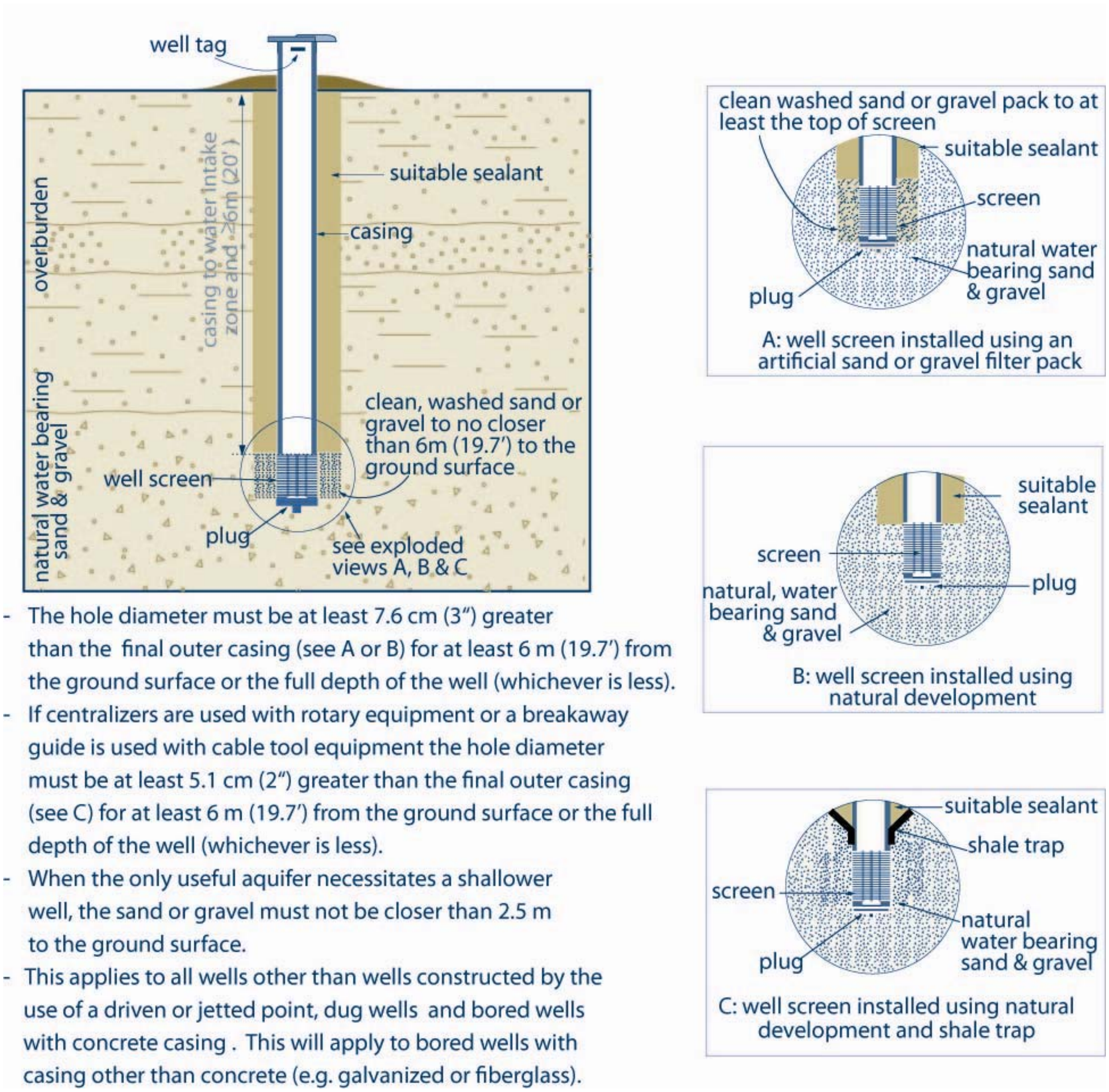
- Chapter 5: *Constructing & Casing the Well*
- Chapter 7: *Completing the Well's Structure*

The illustrations and graphics may not depict every circumstance. Each of the wells shown in Figures 6-6 to 6-13 may encounter conditions that may require specialized design or construction. For example:

- Flowing artesian conditions,
- Presence of gas,
- Breathing (sucking and blowing) conditions where the well and aquifer formation are significantly affected by changes in atmospheric pressure.

All figures and diagrams are for illustrative purposes only and do not necessarily represent full compliance with other requirements found in the **Wells Regulation.**

FIGURE 6-6: DRILLED WELL IN OVERBURDEN – WELL SCREENS THAT ARE ARTIFICIALLY PACKED OR NATURALLY DEVELOPED

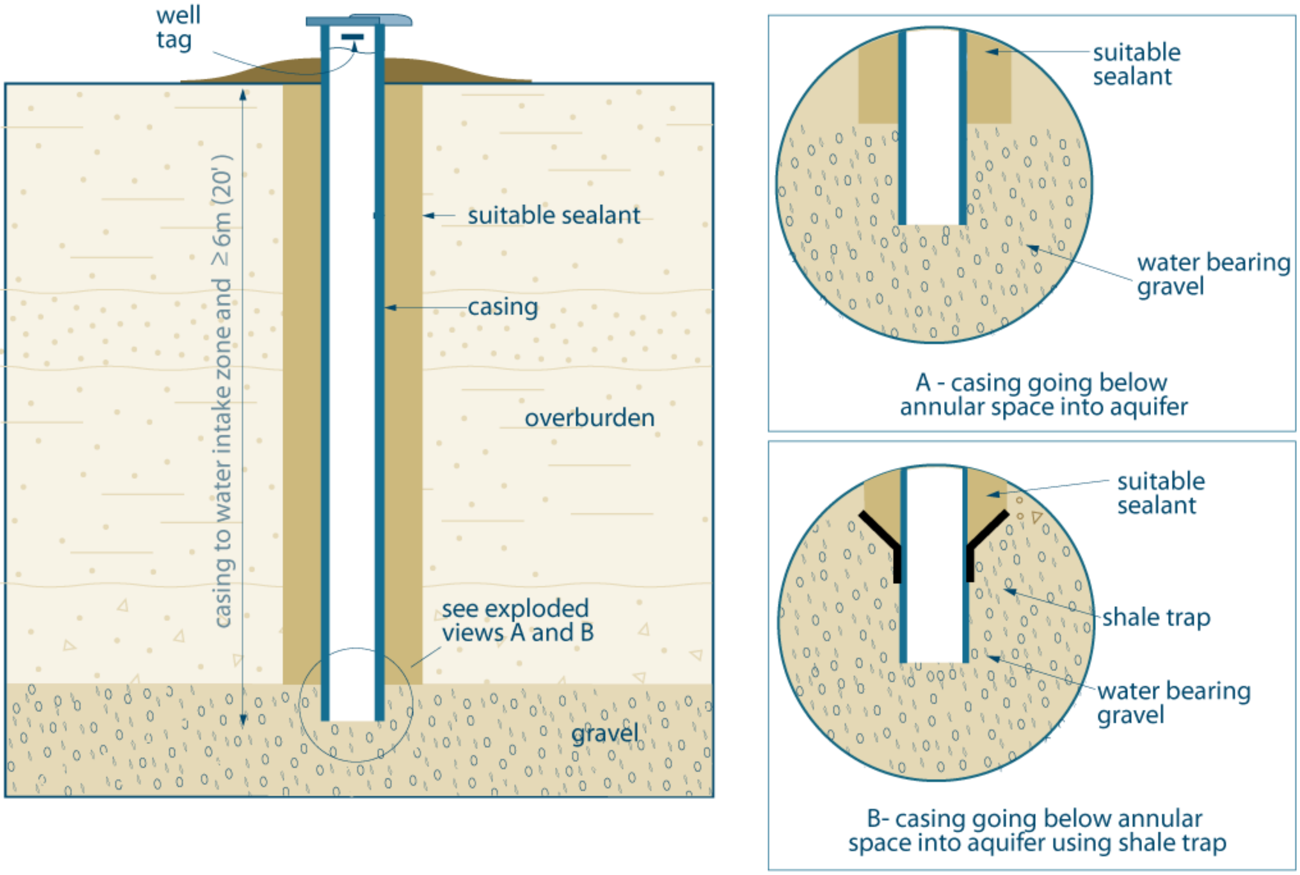


The diagram above is not to scale and is for illustrative purposes for this chapter only.

For information about the use of centralizers with rotary equipment or the use of a breakaway guide with cable tool equipment, see the section titled: "Centering the Casing" in Chapter 5: *Constructing & Casing the Well.*

For further information on the filter pack – see the section titled: "Filter Packs around Well Screens for Drilled Wells," in Chapter 5: *Constructing & Casing the Well.*

FIGURE 6-7: DRILLED WELL – WITHOUT WELL SCREEN

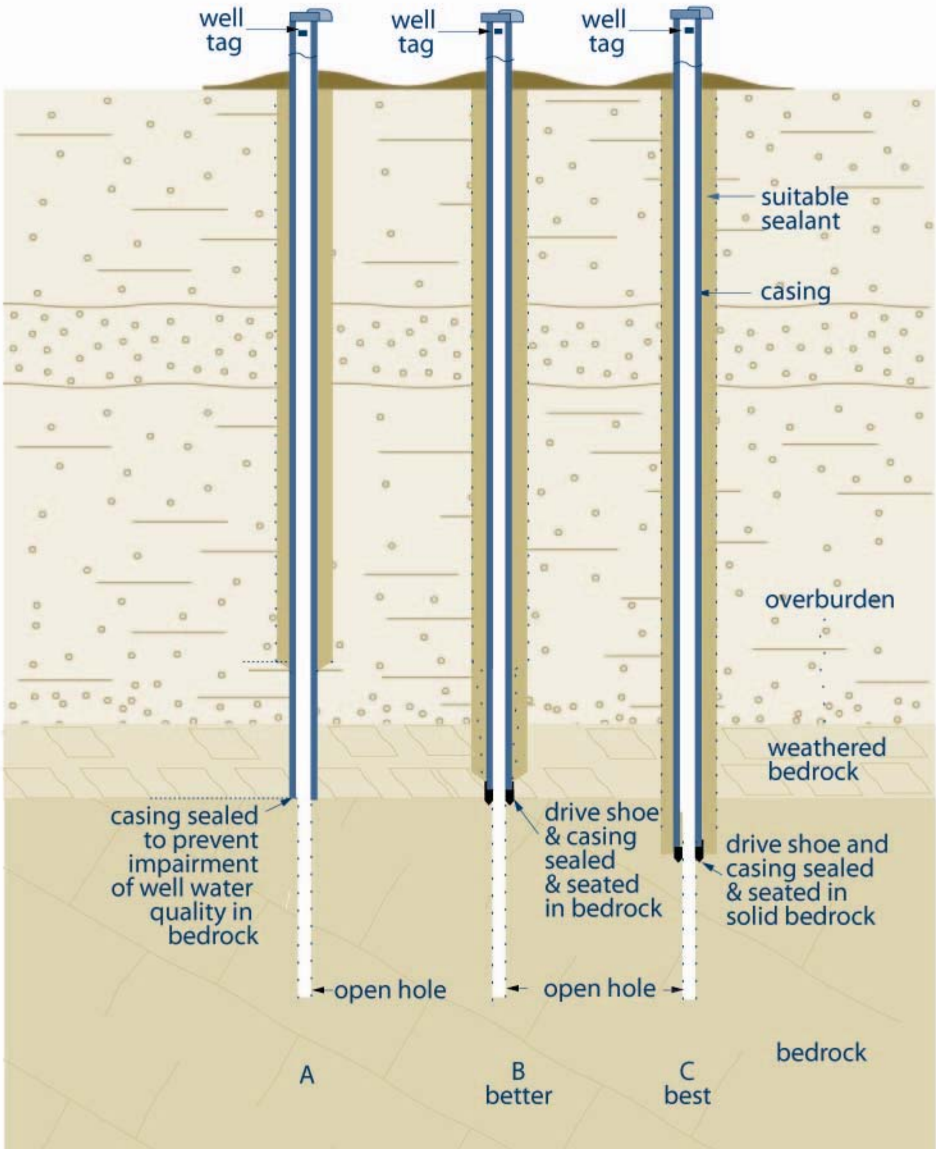


- The hole diameter must be at least 7.6 cm (3") greater than the final outer casing for at least 6 m (19.7') from the ground surface or the full depth of the well (whichever is less).
- If centralizers are used with rotary equipment or a breakaway guide is used with cable tool equipment the hole diameter must be at least 5.1 cm (2") greater than the final outer casing for at least 6 m (19.7') from the ground surface or the full depth of the well (whichever is less).
- This applies to all wells other than wells constructed by the use of a driven or jetted point, dug wells and bored wells with concrete casing . This will apply to bored wells with casing other than concrete (e.g. galvanized or fiberglass).
- In this example, the casing has been driven below the bottom of the annular space.

The diagram above is not to scale and is for illustrative purposes for this chapter only.

For information about the use of centralizers with rotary equipment or the use of a breakaway guide with cable tool equipment, see the section titled: "Centering the Casing" in Chapter 5: *Constructing & Casing the Well.*

FIGURE 6-8: EXAMPLES OF DRILLED WELLS IN BEDROCK

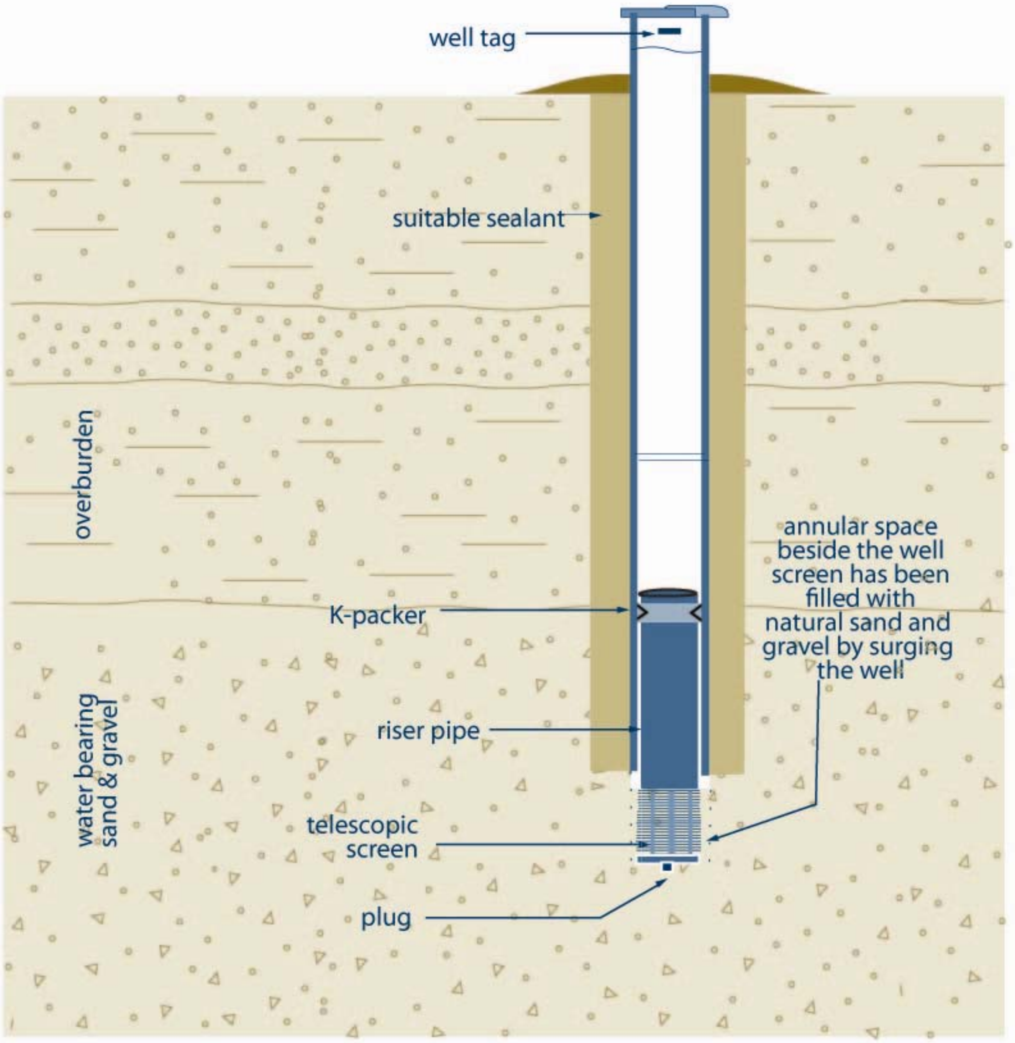


- The hole diameter must be at least 7.6 cm (3") greater than than the final outer casing for at least 6 m (19.7') from the ground surface or the full depth of the well (whichever is less).
- If centralizers are used with rotary equipment or a breakaway guide is used with cable tool equipment the hole diameter must be at least 5.1 cm (2") greater than the final outer casing for at least 6 m (19.7') from the ground surface or the full depth of the well (whichever is less).
- In this example, the casing in A has been driven below the bottom of the annular space so that no further annular space is created.

The diagram above is not to scale and is for illustrative purposes for this chapter only.

For information about the use of centralizers with rotary equipment or the use of a breakaway guide with cable tool equipment, see the section titled: "Centering the Casing" in Chapter 5: *Constructing & Casing the Well.*

FIGURE 6-9: DRILLED WELL IN OVERBURDEN – NATURAL DEVELOPMENT, CASING PULLED BACK EXPOSING SCREEN METHOD



- The hole diameter must be at least 7.6 cm (3") greater than the final outer casing for at least 6 m (19.7') from the ground surface or the full depth of the well (whichever is less).
- If centralizers are used with rotary equipment or a breakaway guide is used with cable tool equipment the hole diameter must be at least 5.1 cm (2") greater than the final outer casing for at least 6 m (19.7') from the ground surface or the full depth of the well (whichever is less).

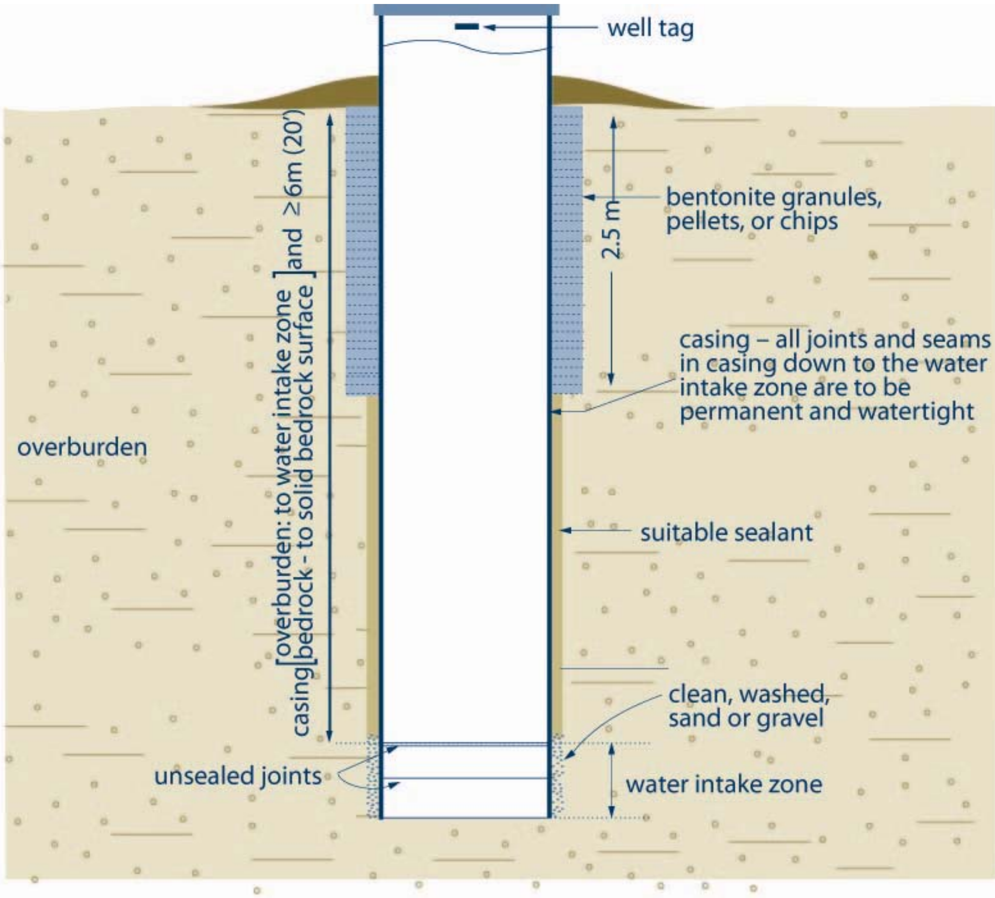
The diagram above is not to scale and is for illustrative purposes for this chapter only.

See Chapter 5: *Constructing & Casing the Well* for further information on this method of well construction.

For information about the use of centralizers with rotary equipment or the use of a breakaway guide with cable tool equipment, see the section titled: "Centering the Casing" in Chapter 5: *Constructing & Casing the Well.*

For further information on the filter pack see the section titled: "Filter Packs around Well Screens for Drilled Wells," of Chapter 5: *Constructing & Casing the Well.*

FIGURE 6-10: BORED WELLS WITH CONCRETE CASING



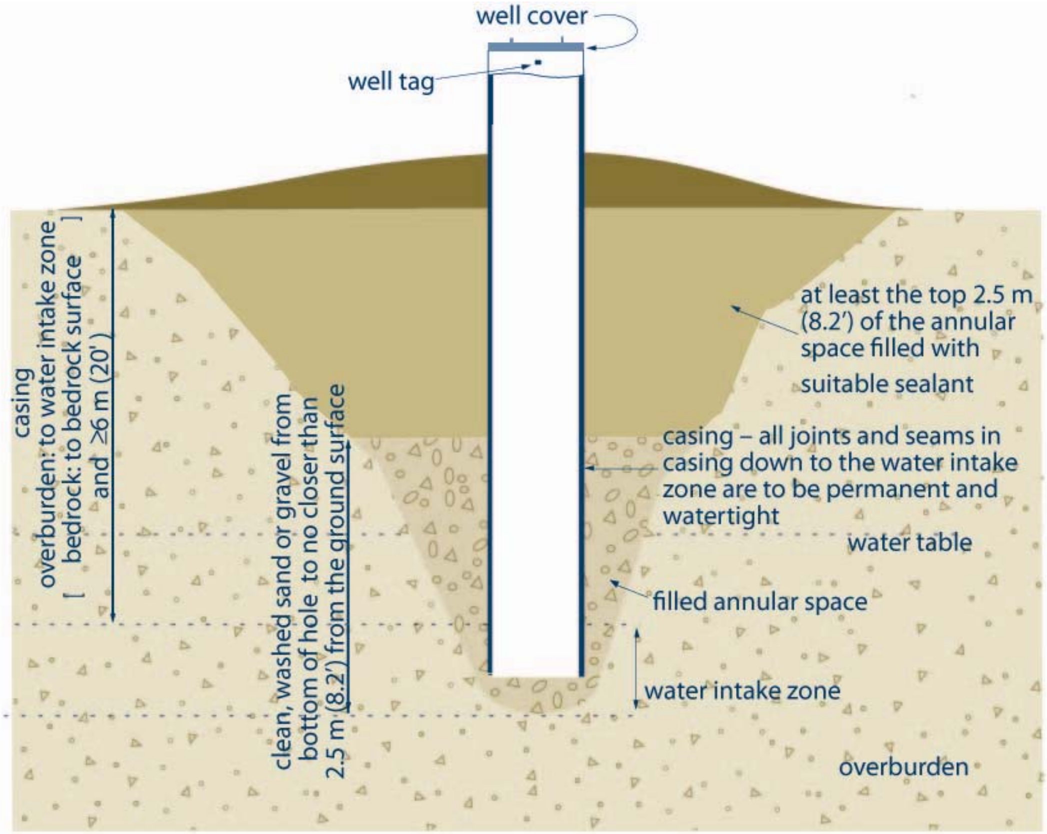
- All concrete tiles with joints that are not sealed with mastic are considered a well screen (water intake zone).
- The hole diameter must be at least 15.2 cm (6") greater than the casing's outer diameter from the land surface to a depth of 2.5 m (8.2').
- The hole diameter must be at least 7.6 cm (3") greater than casing's outer diameter from 2.5m (8.2') to at least 6m(20') below the land surface.
- Sand or gravel must be installed from at least the top of the water intake zone or screen to no closer than 6m (20') below the land surface unless the only useful aquifer available necessitates a shallower well in which case clean, washed sand or gravel must be installed no closer than 2.5 m (8.2') from the land surface.

The diagram above is not to scale and is for illustrative purposes for this chapter only.

For further information about using concrete tiles as well screens, see the section titled: "Well Screens Using Large Diameter Concrete Tiles," in Chapter 5: *Constructing & Casing the Well*.

For further information on the filter pack – see the section titled: "Filter Packs around Well Screens for Drilled Wells," in Chapter 5: *Constructing & Casing the Well*.

FIGURE 6-11: DUG WELL

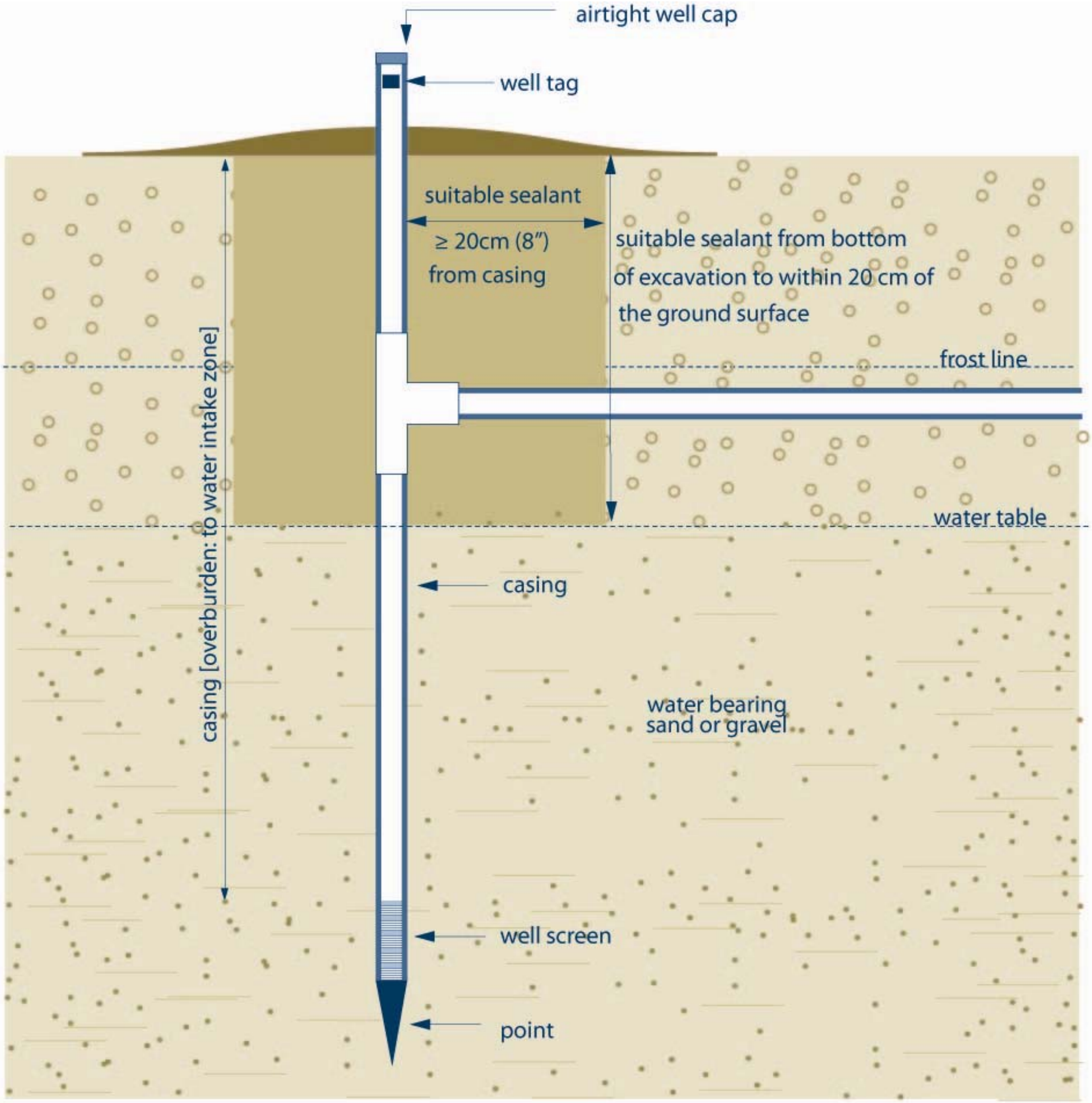


- All concrete tiles with joints that are not sealed are considered well screens (water intake zone).
- Sand or gravel can be replaced with native material (soil) that was excavated from the hole, if the well is not constructed in a contaminated area and the horizons of soil are excavated separately, stored separately, kept free from contamination and backfilled in the same relative positions that they originally occupied.
- Suitable sealant that is used to fill annular space must provide appropriate structural strength to support the weight of persons and vehicles that may move over the well area after it is filled.

The diagram above is not to scale and is for illustrative purposes for this chapter only.

For further information about using concrete tiles as well screens, see the section titled: “Well Screens Using Large Diameter Concrete Tiles,” in Chapter 5: *Constructing & Casing the Well*.

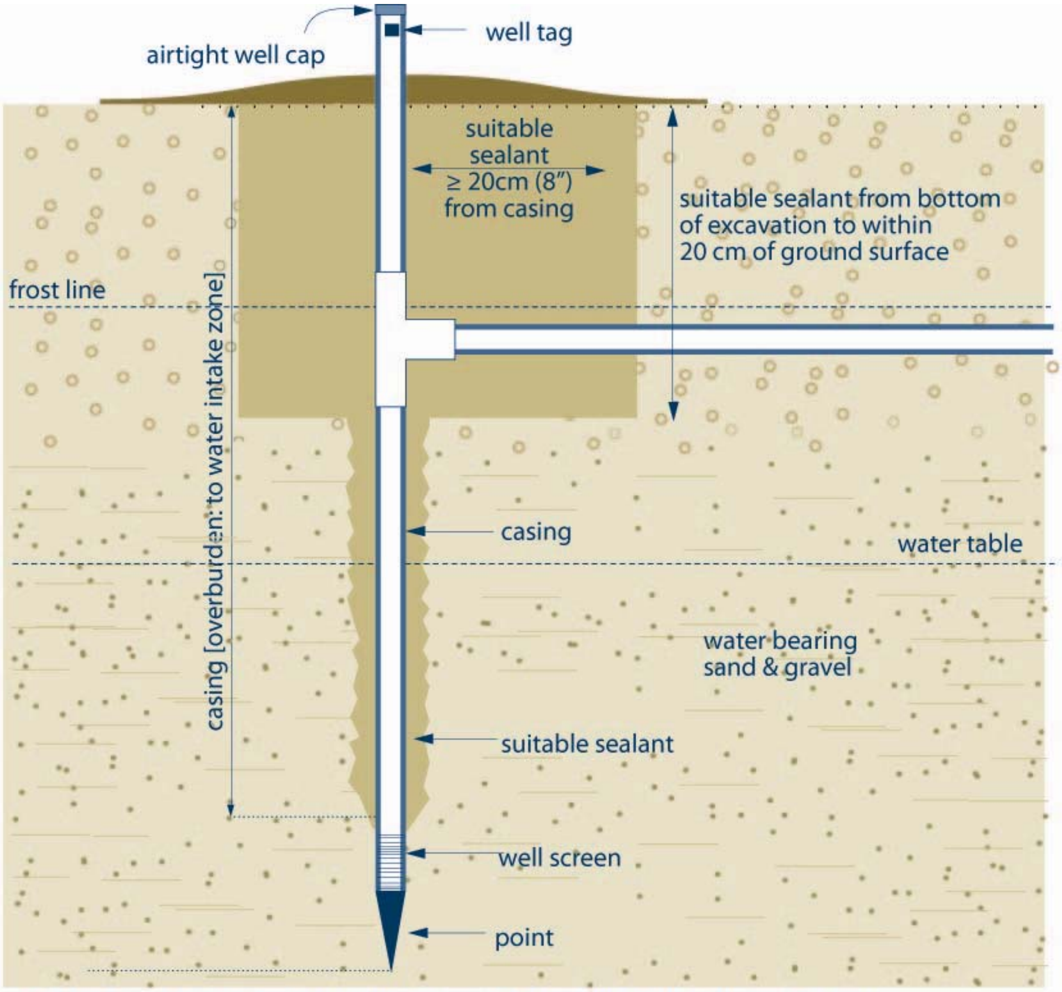
FIGURE 6-12: DRIVEN POINT WELL



- The excavation has been created as a result of installing pumping equipment. To see how this is filled see Chapter 9: *Equipment Installation*, for further instructions.
- If any annular space is created during the driving of the casing, the annular space must be completely filled using materials and a method approved in writing by the Director.

The diagram above is not to scale and is for illustrative purposes for this chapter only.

FIGURE 6-13: JETTED WELL



- The excavation has been created as a result of installing pumping equipment. To see how this is filled see Chapter 9: *Equipment Installation*, for further instructions.
- A person constructing a well by jetting typically creates an annular space around the well casing. The person constructing a well by jetting must ensure that any annular space around a well casing is sealed to prevent any movement of water, natural gas, contaminants, or other material between subsurface formations (aquifers) or between a subsurface formation and the ground surface.

The diagram above is not to scale and is for illustrative purposes for this chapter only.

Comparison of Bentonite and Cement Grouts

The most common sealing materials used are bentonite and neat cement products. Both have specific, unique and desirable properties. Table 6-2 summarizes the advantages, disadvantages and application of bentonite slurry (grout) versus cement based slurries (grouts).

Table 6-2: Some General Bentonite and Cement Advantages and Disadvantages[1]

	Advantages	Disadvantages
Bentonite Based Sealants	• Suitable low permeability with high solids by weight grouts. • Generally non-shrinking and self-healing. • No heat generated during hydration. • Low density. • Sodium bentonite products expand to about 12 to 15 times their original dry volume allowing for less material to be required. • No long curing time required before proceeding with further well drilling. To achieve full gel strength bentonite takes 8 to 48 hours. • Properties such as density can be altered with additives.	• For some grout mixtures with significantly high bentonite solids content (>35%), rapid swelling rate and high viscosity result in difficult pumping through grout pumps and tremie pipes. • Mineralized groundwater (e.g.>5,000 mg/L of total dissolved solids or >8,000 mg/L chlorides) may inhibit its hydration process and its effectiveness as a sealant. This includes source water used in mixing bentonite for a grout. • Flowing well environments will likely diminish bentonite's effectiveness • When filling the annular space, bentonite grouts can leak out into open fractures in bedrock environments. • May have an impact on the groundwater chemistry and the well components because it can trade off cations such as sodium, aluminium, iron and manganese. • Additives that may be added to the bentonite slurry (organic and inorganic polymers) may affect groundwater chemistry near the well • Can make its way through filter packs and screens into the well and into water samples. Thus, it should be placed no closer than 0.9 m (3′) to 1.5 m (5′) above the top of a well screen. • Not suitable for arid climates due to potential for dehydration causing cracking and thus will not perform as a long term effective sealant.

[1] David M. Nielsen. *Environmental Site Characterization and Ground-Water Monitoring: Second Edition.* Taylor and Francis Group, Boca Ratan, FL. 2006. pages 755 – 769.

Cement Based Sealants	• Suitable low permeability. • Easily mixed and pumped. • Hard-positive seal provides structural integrity (good gel strength) and will not erode or wash-out with water movement. • Supports and adheres to casing. • Any remaining casing is rendered permanent and non-movable. • Adheres well to bedrock. • Properties can be altered with additives to reduce hydration time (calcium chloride), to make it stronger (aluminum powder), or have a higher resistance to sulphate rich environments (fly ash). • Expanding cements, Types K, M and S, have characteristics and shrinkage-compensating additives that work well as annular seals • Air-entrained cements work well in cold weather climates because cement with air-entraining agents has water tightness and freeze thaw resistance. • Provides weight and strength to overcome pressures associated with flowing wells.	• Possible shrinkage if extra water is used, if improper additives are used or if the person is not using shrinkage compensated cements. • Settling problems occur if not properly mixed or placed. • Long curing time (minimum 12 hours) increases time to complete well and install equipment in well. • Produces high heat levels during hydration process that can distort some plastic casings. The high heat of hydration in combination with weight of grout also increases the potential for plastic casing to distort or collapse. • High density results in loss of grout to some permeable overburden and bedrock formations. • If prompt equipment cleanup does not occur, equipment damage may result. • In order to properly set, mixing water needs to be cool, clean, fresh water free of oil soluble chemicals, organic material, alkalies, sulphates and other contaminants. • In order to properly set, mixing water needs to have a total dissolved solids concentration of less than 500 mg/L. • Using water that has a high pH may increase setting time. • Equipment such as a tremie pipe needs to be kept cool to prevent flash set problems to pumps and tremie pipes. • If too much water is used in the mixture, the extra water cannot chemically bind with cement (called bleed water), becomes highly alkaline and then can percolate through cement, bentonite and filter pack material causing contamination in groundwater. Voids in the cement created by this bleed water can also be subject to chemical attack and thus, will not perform as a long term effective sealing material. • Prolonged mixing can interrupt heat of hydration process and reduce strength and cement quality. • Neat cement mixtures increase the pH in the subsurface formations. An increase in pH can cause dissolved metals to precipitate from solution onto well components like the well screen, and can cause a negative bias in groundwater sample analyses compared to actual ambient groundwater concentrations. • Weight of cement may increase hydraulic pressure on filter pack and thus compromise and permanently plug the pack material and well screen. • Too thin of a cement mixture may also allow cement to penetrate, compromise and permanently plug the pack material and well screen.

Notes Regarding Table 6-2:

Suitable sealant must be compatible with the quality of the water in the well.

Sealant must be a bentonite mixture of clean water and at least 20 percent solids by weight, or a product that will be equivalent with respect to the ability to form a permanent watertight barrier (see Chapter 2: *Definitions & Clarifications,* Table 2-2.) For example, a mixture of water with cement, concrete or cement with no more than 5 percent bentonite solids by weight may be an equivalent sealant in some environments.

When evaluating bentonite as an annular sealant, consider the following:

- The position of the static water level and its seasonal fluctuations
- The ambient groundwater and mixing water quality

In some cases 3 to 8 percent of bentonite is used as an additive to cement or concrete to improve the workability, slurry weight and density of the cement slurry. However, bentonite is chemically incompatible with cement causing bentonite's swelling ability to reduce. The bentonite additive also reduces the set strength of the seal and lengthens set time.

Calculating Amount of Materials Required

Before beginning, calculate the amount of materials (sand, gravel and bentonite and/or cement) required to properly seal the annular space. Regardless of the base materials or type of grout, it is the measured amount of water and the consistent use of that ratio of water to the dry product that is ultimately the key element to achieving the appropriate grout properties.

The amount of material needed will depend on the volume of annular space that needs to be filled (i.e. width of the annular space and depth of the annular space).

Some things to remember when calculating the amount of materials required:

- Allow for possible hole increases due to drilling actions, geology and flushing media. Consider adding 10% to 15% more material to the calculated amount.
- Volume is a measurement of the amount of space occupied by a three-dimensional object as measured in cubic units [e.g. gallons, quarts or litres, cubic metres (m^3) or cubic feet (ft^3)].
- The volume of the hole that the casing will occupy must be accounted for.
- When calculating volume, make sure that all measurements are of the same type. For example, all three dimensions are metres, or inches, or feet or whichever type of measurement used.

Volumes on the packaging will typically be in metric or U.S. units.

The following formulae can be used to calculate the volume of the annular space.

METHOD 1

ANNULAR SPACE VOLUME = VOLUME OF HOLE - VOLUME OF CASING, WHERE:

$$\text{VOLUME OF HOLE} = 3.14 \times \left(\frac{\text{DIAMETER OF HOLE}}{2}\right)^2 \times \text{DEPTH}$$

AND

$$\text{VOLUME OF CASING} = 3.14 \times \left(\frac{\text{OUTER DIAMETER OF CASING}}{2}\right)^2 \times \text{DEPTH;}$$

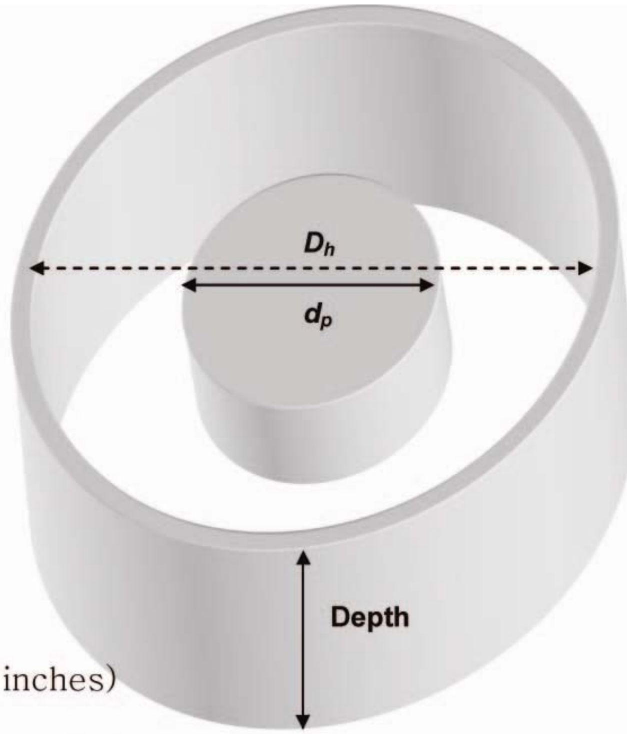
OR

$$\text{VOLUME OF HOLE} = 0.785 \times \text{DIAMETER}^2 \times \text{DEPTH OF HOLE}$$

AND

$$\text{VOLUME OF CASING} = 0.785 \times \text{DIAMETER}^2 \times \text{DEPTH OF HOLE}$$

METHOD 2



WHERE:

D_h = Diameter of Hole (mm or inches)

d_p = Outer diameter of pipe (casing) (mm or inches)

$$\left(\frac{D_h(\text{mm})^2 - d_p(\text{mm})^2}{1273}\right) \text{x Depth (metres)} = \text{Annular Space Volume (Litres)}$$

OR

$$\left(\frac{D_h(\text{inches})^2 - d_p(\text{inches})^2}{29.45}\right) \text{x Depth (feet)} = \text{Annular Space Volume (Imperial Gallons)}$$

The exact amount of grout required cannot always be determined due to irregularities in the size of the hole and losses into fractured rock. Be prepared with extra material onsite to add to the initial estimate on short notice.

See the section titled: “Tools” at the end of this chapter for a Grouts and Sealants Application Matrix to help calculate the amount of grout required to fill the annular space (Table 6-5).

The following tables can be used to calculate the volume of sealant (i.e. bentonite, cement, concrete) yielded per bag of product.

Table 6-3: Calculating Volume of Bentonite [at 15%, 20% and 23% Solids based on one 23 kg (50 lbs) bag of Sodium Bentonite]

	% Solids Grout		
	15	**20**	**23**
Water - Litres	125	91	76
Water - Imperial Gallons	33	24	20
Yield Volume - Litres	133.6	99.6	84.4
Yield Volume - Imperial Gallons	29.4	21.9	18.6

Table 6-4 is based on one 43 kg (94 lbs) bag of cement and the volume of concrete based on one 43 kg (94 lbs) bag of cement mixed with 0.027 cubic metres (1 cubic foot) of sand or gravel (Portland cement).

Table 6-4: Calculating Volume of Concrete and Cement

	Concrete	Portland Cement
Water - Litres	19.7	19.7
Water – Imperial Gallons	4.3	4.3
Yield Volume – Litres	60.3	33.3
Yield Volume – Imperial Gallons	13.3	7.3

One litre of water weighs one kilogram and Portland cement produces a slurry weight of 1.87 kg/L.

Mixing Bentonite Grout (Sealant)

When mixing grout, it is important to follow the manufacturer's specifications provided on the packaging or with the product.

Inhibited bentonite grouts (sealants) are a powdered type material that is designed to slow the rate of hydration just long enough to allow the bentonite to be placed into the annular space.

Best Management Practice – Mixing Bentonite Grout

When mixing bentonite material with clean water it is important to use a high shear paddle mixer in a mixing drum to thoroughly shear the bentonite particles to suspension. Once properly mixed, the bentonite grout (sealant) is pumped through a tremie pipe to fill the annular space. Positive displacement pumps with minimal shearing action are needed when placing bentonite grout (sealant) in the annular space. This technique allows for proper placement and hydration of the bentonite grout (sealant) in the annular space.

Techniques for Successful Mixing

- Mix bentonite with clean water to ensure that the bentonite sealant will last the life of the water well. 'Clean' means water that will not interfere with the reaction to make a bentonite slurry as recommended by the manufacturer and will not impair the well water.
- Do not assume that potable water sources (municipal water, etc.) are acceptable sources of mixing water for bentonite drilling mud or sealant. It is important to always test or, if available, review any water quality reports for the mixing water for pH, hardness, total dissolved solids and chlorides before mixing.
- Mix bentonite with clean water until suspension is achieved. Immediately pump material into the annular space through a tremie pipe.
- Prepare small batches to ensure that at least 20% bentonite solids by weight is maintained.
- Use gear pumps for bentonite sealants consisting of bentonite polymer and water mixtures (two step grouts).
- Use progressing cavity pumps for bentonite sealants consisting of bentonite and water mixtures (one step grouts).

Consequences of Poorly Mixed Bentonite Grout

- Mixing water that is highly mineralized may inhibit the hydration process of the bentonite grout and its effectiveness as a sealant.
- If excess "hardness" is present in the mixing water, the bentonite may clump and adhere to the paddles during the mixing phase. In severe cases it can result in plugging of tremie lines and disruption of the grouting process.
- Grout that is mixed or sheared too much will start to hydrate too rapidly. This will result in difficulty pumping the grout, plugging up of the tremie line and wasting a batch.

It is important to follow the manufacturer's specifications for pH, hardness, chloride, total dissolved solids and other water quality issues.

Mixing Cement or Concrete Grout (Sealant)

Cement grout (sealant) must be made using carefully measured quantities of water and Portland cement (see Table 6-4). In concrete grout, aggregate and other materials (e.g. plasticizers) are added to cement and water. Further information on cement can be found at the following website titled “Cement and Concrete Basics:” http://www.cement.org/basics/concretebasics_history.asp

A paddle mixer in a mixing drum with either a progressive cavity or gear pump are common choices for mixing and pumping cement or concrete grout (sealant). Small portable grouting machines that combine both the mixing and the pumping operations are also often used. These machines typically have a positive displacement pump because it can work efficiently against much greater head pressures with low loss of grout volume.

Techniques for Successful Mixing[2]

Best Management Practice – Techniques for Successful Mixing

- Mixing water needs to be cool, clean, fresh water free of oil soluble chemicals, organic material, alkalies and other contaminants and have a total dissolved solids concentration of less than 500 mg/L to ensure proper setting of the grout (sealant).
- It is important that grout be mixed thoroughly and be free of lumps.
- If the mixture is purchased from a ready-mix concrete plant, the correct proportions of cement, water and other aggregate material, if present, must be verified by using equipment such as a drilling fluid balance.
- It is important to use a protective strainer on the tank from which the grout is pumped.
- Immediately pump material into the annular space through a tremie pipe.

Consequences of Poorly Mixed Cement Grout

- Mixing water that has a high level of total dissolved solids or high pH may result in increased setting times and/or failure to set.
- If the grout is not thoroughly mixed and free of lumps then partial setting may occur and the effectiveness of the seal will be compromised.
- Premature setting may occur due to the incorrect assumption of hole temperature, use of hot mixing water, improper water to cement ratios, contaminants in the mixing water, mechanical failures, and interruptions to pumping operations.
- Improper water to cement ratios may also cause excessive shrinkage of the grout.

[2] Sterrett, Robert J. 2007. *Groundwater and Wells-Third Edition*. Johnson Screens/a Weatherford Company., New Brighton, MN. P 453-454.

Grout Placement Requirements

The **Wells Regulation** has specific requirements for the placement of materials in the annular space (see Table 6-1 in "Requirements Plainly Stated").

The **Wells Regulation** requires that any annular space of any new cased well, other than the annular space surrounding the well screen, must be sealed to prevent any movement of water, natural gas, contaminants or other material between subsurface formations or between subsurface formations and the ground surface by means of the annular space.

The **Wells Regulation** requires that a tremie pipe be used to install the suitable sealant and that the bottom of the tremie pipe remain immersed in the rising accumulation of sealant for all new wells except dug wells, wells constructed with the use of a driven point and wells constructed by jetting.

Successful placement of the grout will depend on the temperature, stability, size of the annular space and pressure in the hole, and how well the casing is centered, and the grouting placement.

Best Management Practice – Sealing the Annular Space

The following will help to assure that the sealant will provide a satisfactory seal:

- During placement of sealant, the sealant returning to the surface should be of the same consistency of that being pumped.
- The first indication of sealant returning to surface is not an indication to stop pumping.
- Where the tremie pipe is placed in the annular space, active pumping of the sealant should continue as the tremie pipe is extracted from the annular space to ensure effective displacement.
- Sealant pump suction and discharge hoses should be adequately sized to overcome friction losses and decrease chances of plugging.
- Suction and discharge hose connections to the pump should be made using quick-connect style couplings. This will save time when attempting to locate a blockage in the hose and allow faster cleanup.
- When the pump is also used for mixing, the discharge hose should be plumbed in such a manner to allow changeover from mixing to pumping sealant without shutting down the pump.
- A pressure gauge should be installed on the pump discharge and monitored to ensure that the working pressure does not exceed the hose and pipe maximum pressure rating. A sudden increase in pressure may indicate that the tremie pipe has become plugged.

Grout Placement – Inner String Method

In the inner string method of placing grout, the tremie is suspended in the casing. A cementing (float) shoe is attached to the bottom of the casing before the casing is placed in the hole. The tremie pipe is lowered until it engages the shoe.

Placing Grout Using the Inner String Method

To place grout using the inner string method:

1. Attach a float shoe or other similar device to the bottom of the casing before the casing is placed in the hole.
2. Place the casing in the hole to the bottom of the well. Then lower the tremie pipe inside the casing until it engages the shoe. This permits the grout to pass into the annular space but prevents it from leaking back into the casing while grouting.
3. Place water or drilling fluid into the casing to prevent the grout from coming back up the casing.

   For shorter strings of casing [i.e. 6 to 30 metres (20′ to 100′)] seal the tremie pipe at the top of the casing using one or two stacked top well seals. The barrier created by the well seals along with the weight of the drilling fluid or water will minimize the amount of grout that can travel back up the inside of the casing string during and after the pumping process.
4. Pump the grout through the tremie pipe and float shoe and force it upward around the casing.
5. Disconnect and remove the tremie pipe.
6. Clean up all grouting equipment.

7a. Where bentonite grout is used and before further well construction proceeds, the bentonite should be allowed time to achieve gel strength. Bentonite takes 8 to 48 hours to achieve full gel strength.

Best Management Practice – When Bentonite Grout Settles

The bentonite grout should be topped up to the original level before drilling continues if there has been settling or subsidence in the annular space.

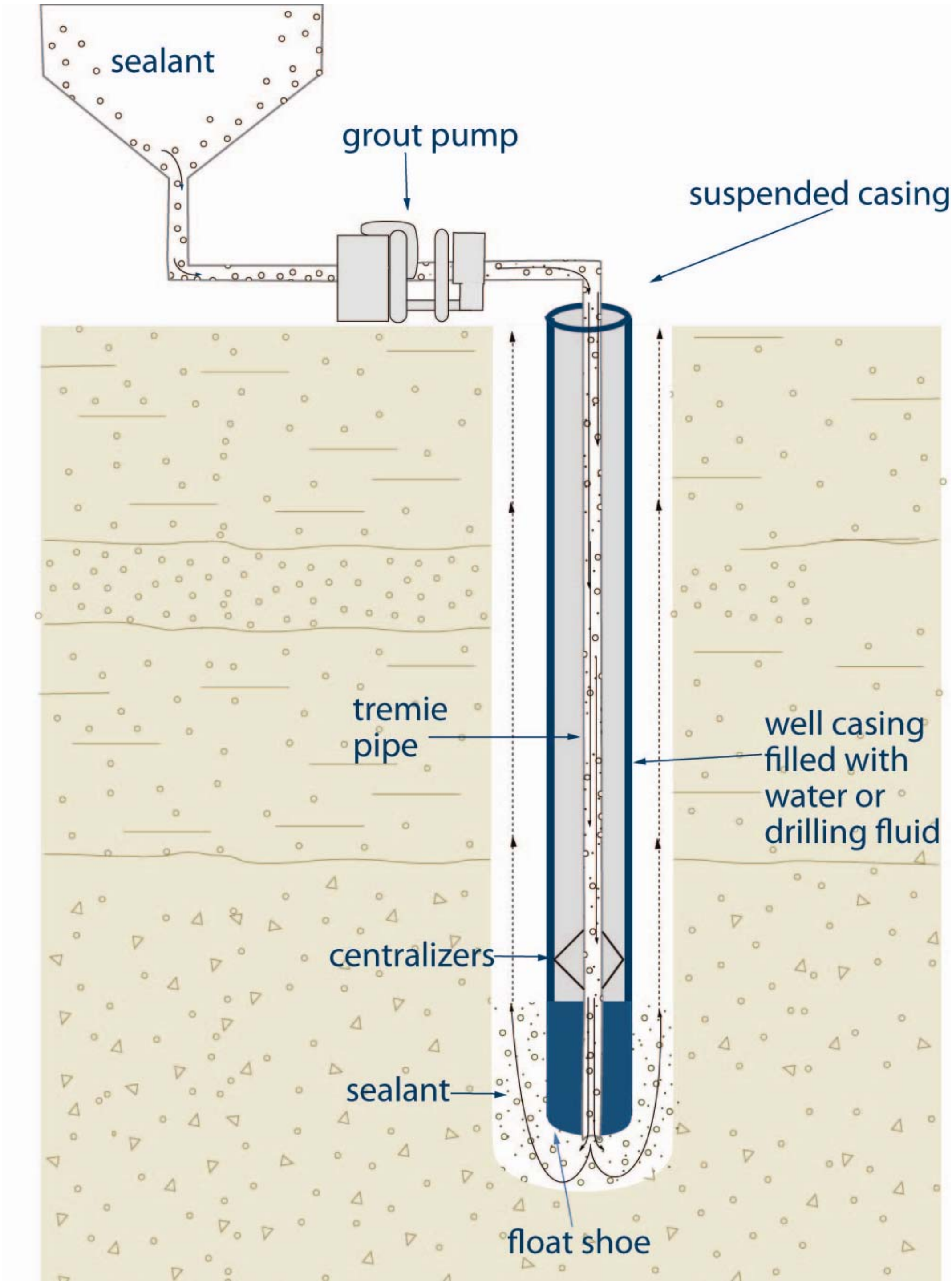
7b. Where cement grout is used, cement must be allowed to set according to manufacturer's specifications, or 12 hours, whichever is longer. If there has been settling or subsidence in the annular space, the cement grout must be topped up to the original level before drilling continues.

8. Drill out or remove the float shoe or other device from the bottom of the casing.

The sealant at the bottom of the casing is vulnerable when drilling restarts. The sealant must be physically and structurally sound and capable of withstanding the initial pressures of drilling. It is important to avoid upward movement of flushing media or grout column on the outside of the casing when starting to drill after placement of grout. This upward movement can be caused by the displacement of water in the casing when using the percussion drilling action or when using air or water based flushing media.

FIGURE 6-14: PUMPING GROUT DOWN TREMIE PIPE – INSIDE CASING

FIGURE 6-15: INNER STRING METHOD OF GROUT PLACEMENT



The diagram above is not to scale and is for illustrative purposes for this chapter only.

All figures and diagrams are for illustrative purposes only and do not necessarily represent full compliance with other requirements found in the **Wells Regulation.**

Grout Placement – Tremie Pipe Outside Casing Method

When using this placement method, the grout material is pumped or placed using a tremie pipe that is installed in the annular space.

Best Management Practice – Use of a Grout Pump

When a grout pump is used with a tremie pipe, it is important that any fluid (i.e. drilling mud or water) of less weight than the grout be displaced from the annular space ensuring that any voids or spaces are filled with grout (sealant).

Best Management Practice – Use of a Larger Diameter Tremie Pipe

It is important to use as large a tremie pipe as possible because it:

- Reduces the amount of friction loss that is natural for a small diameter tremie pipe
- Reduces the velocity of grout entering the annular space
- Enhances the efficiency of the displacement process
- Significantly improves the effectiveness of the overall seal

The annular space must meet regulatory requirements (see Table 5-5 of Chapter 5: *Constructing and Casing the Well*, and Table 6-1 of this chapter) and be large enough to accommodate the tremie pipe (Best Management Practice: Size of Hole, on page 26 of Chapter 5: *Constructing and Casing the Well.*))

Placing Grout Using the Outside Casing Method

To place grout using the tremie pipe outside casing method:

1. Close the lower end of the casing with a drillable plug to ensure the grout that is placed in the annular space cannot enter the casing.

   Another option is to drive the casing into the undisturbed formation below the hole.

2. Install the tremie pipe into the annular space and ensure the tremie pipe reaches the bottom of the annular space.

3a. If a pump is used, the grout is pumped down the tremie pipe discharging into the bottom annular space. Continued discharge of grout into the bottom of the annular space causes the rising accumulation of grout to the ground surface.

   The pump must be capable of developing enough pressure to overcome the friction caused by moving the grout through the tremie pipe and up the annular space.

Issues with a grout pressure head that may prevent the upward placement of grout with a pump are not usually a concern since the grout that is rising to the ground surface is at or below the grout pump elevation.

In some circumstances it may be advisable to pull the tremie pipe at about the same rate that grout is filling the annular space after the first mixed batch of grout is pumped into the annular space. This will minimize the grout pressure head on the tremie pipe outlet and reduce any chances of the tremie pipe being stuck in the hole due to hydration of the grout.

3b. If a pump is not used, the grout is poured down a tremie pipe above the ground surface. The grout flows from the tremie pipe into the bottom annular space by force of gravity. The tremie pipe is raised slowly and the bottom of the tremie pipe remains in the rising accumulation of grout until grout reaches the ground surface.

Ontario The bottom of the tremie pipe must remain submerged in the rising accumulation of grout until placement of the grout is complete.

4. Grouting may be complete when the grout leaving the annular space at the ground surface is of the same consistency as the grout being introduced into the bottom of the annular space.

5. Disconnect and remove the tremie pipe.

6. Clean all grouting equipment.

7a. Where bentonite grout is used and before further well construction proceeds, the bentonite should be allowed time to achieve gel strength. To achieve full gel strength bentonite takes 8 to 48 hours.

Best Management Practice – When Bentonite Grout Settles
If there has been settling or subsidence in the annular space, top up the bentonite grout to the original level before drilling continues.

Ontario 7b. Where cement grout is used, cement must be allowed to set according to manufacturer's specifications, or 12 hours, whichever is longer. If there has been settling or subsidence in the annular space, the cement grout must be topped up to the original level before drilling continues.

8. Drill out or remove the plug from the bottom of the casing.

The sealant at the bottom of the casing is vulnerable when drilling restarts. The sealant must be physically and structurally sound and capable of withstanding the initial pressures of drilling. It is important to avoid upward movement of flushing media or grout column on the outside of the casing when starting to drill after placement of grout. This can be caused by the displacement of water in the casing when using percussion drilling action or when using air or water based flushing media.

Figure 6-16: Outside Casing Method

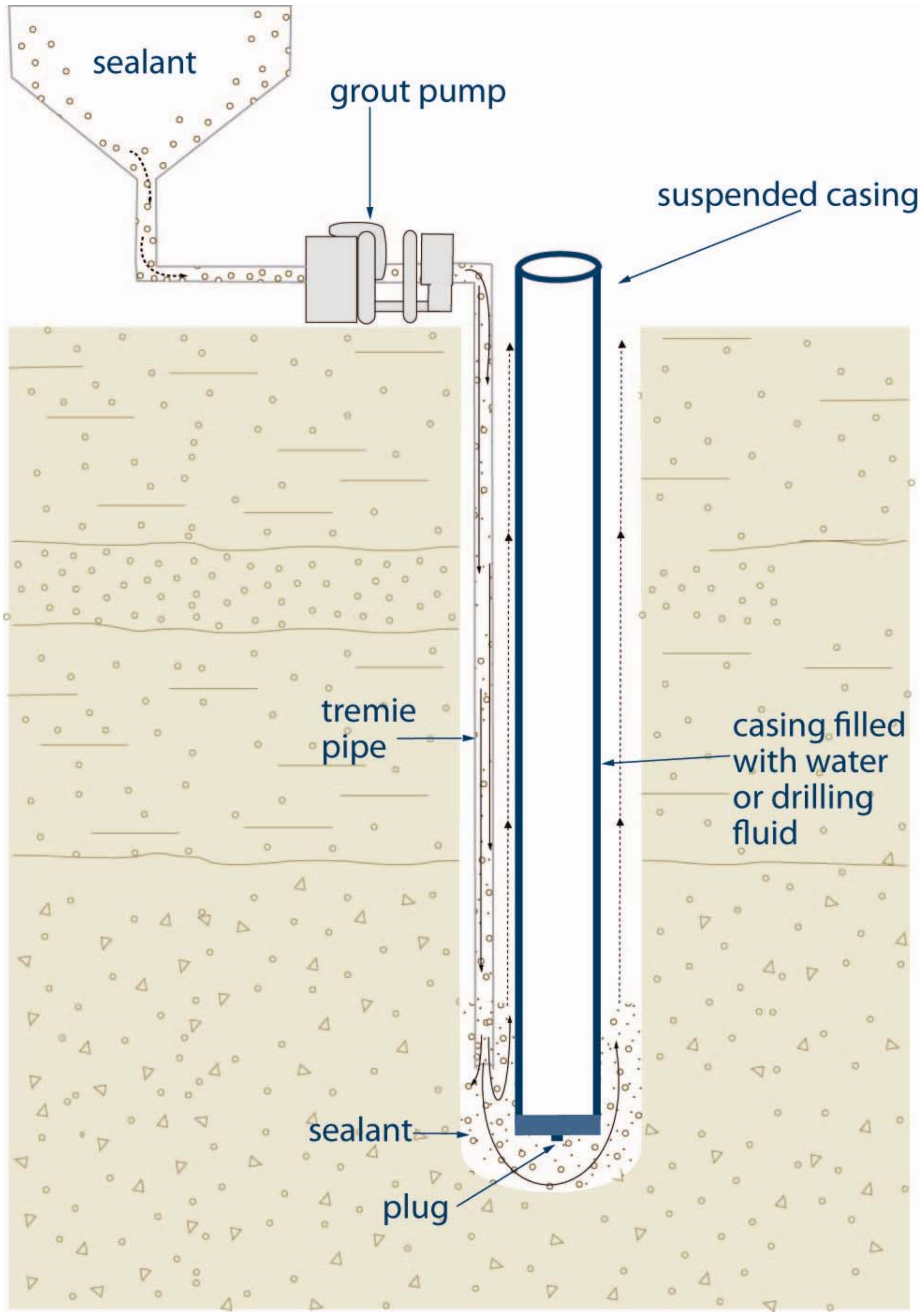


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FIGURE 6-17: INSTALLING TREMIE PIPE OUTSIDE CASING

FIGURE 6-18: A SUCCESSFUL SEAL

FIGURE 6-19: TREMIE REMAINS IN HOLE DURING GROUT PLACEMENT

FIGURE 6-20: HOLE EXCAVATED BESIDE DRILLED WELL

FIGURE 6-21: BENTONITE GROUT IN ANNULAR SPACE

Figure 6-20 shows a hole excavated beside a drilled well. The photograph shows the bluish-grey coloured bentonite grout that has filled the annular space of the drilled well adjacent to the black coloured drilled well casing. The bentonite has also adhered to the sand and gravel overburden. The pop can adjacent to the casing near bottom of excavation provides approximate thickness of grout.

In Figure 6-21 the same drilled well is depicted. The bluish grey coloured bentonite grout can be seen. The grout has filled the annular space of the well adjacent to the black coloured drilled well casing and adhered to the sand and gravel overburden.

Grout Placement – Pouring Without Tremie Pipe

When filling the annular space of dug wells and the upper 2.5 metres (8.2′) of bored wells with approved concrete casing, a tremie pipe is not required.

The grout (sealant) must provide appropriate structural strength to support the weight of persons and vehicles that may move over the annular space of a dug well or well pit.

Care is needed when filling the annular space around a large diameter casing that is thin walled (e.g. fiberglass or corrugated steel) to reduce the risk of distorting the casing wall or casing joints. Care is also needed when pouring suitable sealant to ensure that bridging will not occur.

Grout Placement – Displacement Method

The displacement method involves calculating a volume of sealant (grout) material needed to fill the annular space.

1. In many cases, a starter casing is placed into the hole to support the sides of the well. The sealant is typically installed into the drilled hole by a gravity method such as pouring the material from the ground surface. In this case the starter casing acts as a tremie pipe.

   For further clarification of the definition of Tremie Pipe see Chapter 2: *Definitions and Clarifications*, Table 2-1

   In other cases a tremie pipe is lowered into the open hole and the grout is placed into the open hole through a tremie pipe.

2. A well casing with a plug located on the bottom of the casing is installed into the hole. The grout (sealant) is displaced by the casing and pushed up into the annular space.

3. If the sealant does not fill the entire annular space beside the well casing, then the sealant must be topped up using a tremie pipe to fill the entire annular space to the ground surface.

4a. Where bentonite grout is used and before further well construction proceeds, allow the bentonite time to achieve gel strength. To achieve full gel strength bentonite takes 8 to 48 hours.

Best Management Practice – When Bentonite Grout Settles

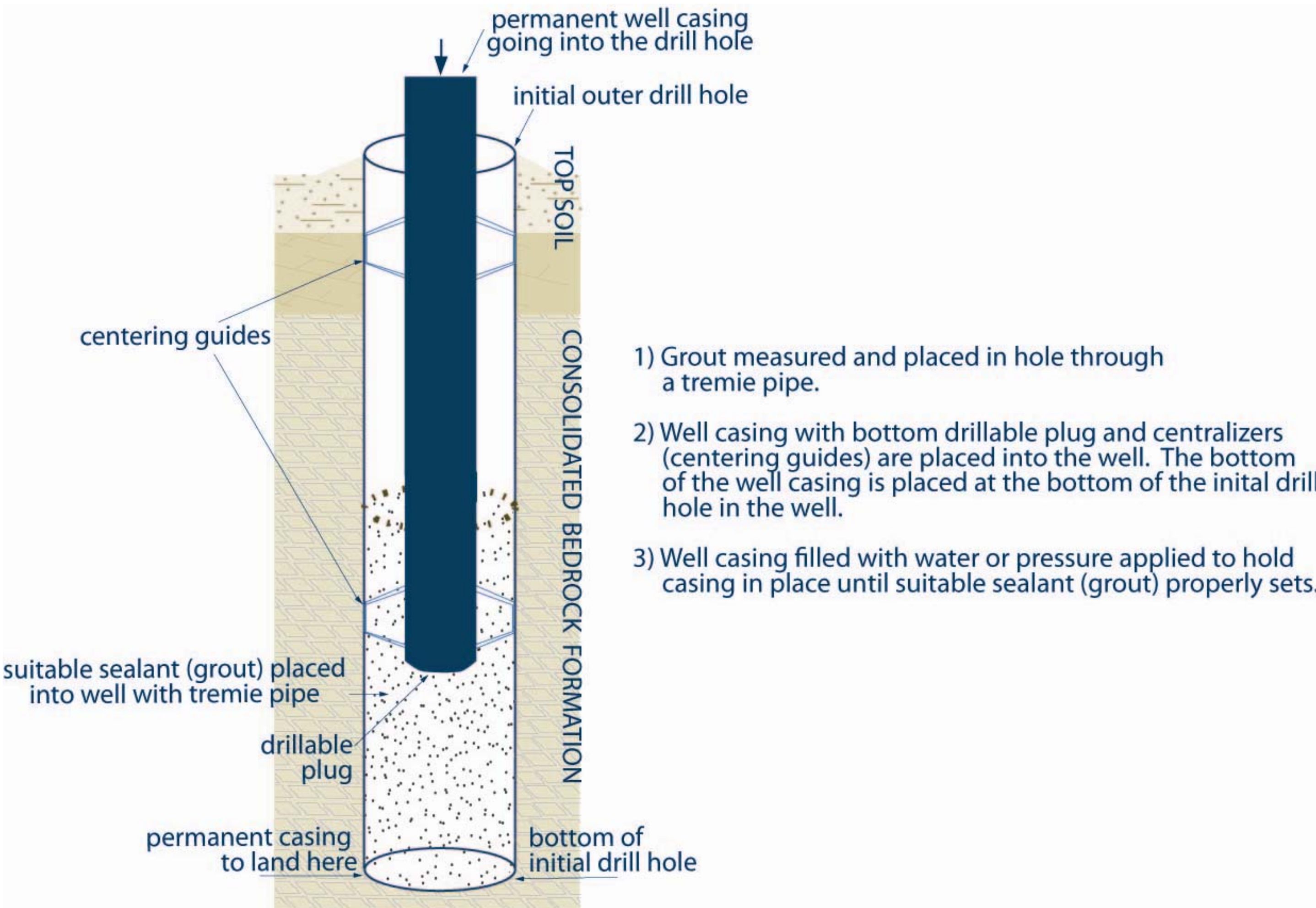
If there has been settling or subsidence in the annular space, top up the bentonite grout to the original level before drilling continues

4b. Where cement grout is used, cement grout must be allowed to set according to manufacturer's specifications, or 12 hours, whichever is longer. If there has been settling or subsidence in the annular space, the cement grout must be topped up to the original level before drilling continues.

5. Drill out or remove the plug from the bottom of the casing.

The displacement method using a tremie pipe allows the sealant to be continuously deposited into the hole. The casing with plug can then be installed into the well and meets the requirements of the **Wells Regulation**. The volume of sealant placed in the hole must be able to rise from the bottom of the annular space to the ground surface.

FIGURE 6-22: GROUT DISPLACEMENT METHOD



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Grout Placement – Double Plug Procedure[3]

The method is more common in the construction of oil and gas wells than water wells. It involves calculating a volume of grout (sealant) material needed to fill the annular space. As this method involves installing the pre-determined batch inside the well casing and pushing it into the annular space from below the well casing, care must be taken to determine if the volume of grout (sealant) within the well casing exceeds the volume of the entire annular space.

When determining the volume of grout needed, it is important to include an amount of grout that will leave 3 m (10′) to 4.6 m (15′) of grout (sealant) in the casing after the annular space has been filled.

1. A casing with a plug is installed in the hole. The casing is held above the bottom of the well. A pump and pipe are hooked onto the casing above the ground surface.

Plugs should be made of material that is easily drilled through (e.g. cement).

2. Grout (sealant) is pumped into the casing above the plug. In this case the casing acts as the tremie pipe.
3. A second plug is installed above the grout. The use of a plug helps ensure slurry and water separation, resulting in a proper grout seal at the lower end of the casing.
4. Clean water or drilling fluid is then pumped into the casing causing the plugs and grout to move down the casing. As the plugs move down the casing, water or drilling fluid inside the casing is displaced. The process allows the lower plug to fall below the bottom of the casing and the grout moves up and into the annular space.

5a Where bentonite grout is used and before further well construction proceeds, the bentonite should be allowed time to achieve gel strength. To achieve full gel strength bentonite takes 8 to 48 hours.

Best Management Practice – When Bentonite Grout Settles

If there has been settling or subsidence in the annular space, top up the bentonite grout to the original level before drilling continues

5b. Where cement grout is used, cement grout must be allowed to set according to manufacturer's specifications, or 12 hours, whichever is longer. If there has been settling or subsidence in the annular space, the cement grout must be topped up to the original level before drilling continues.

6. Drill out or remove the plugs from the bottom of the casing.

Landing collars below the lower plug can be used to reduce the potential for over or under displacement of the grout (sealant). Wire lines attached to the upper plug can also be used to assist in accurately measuring depths when the plugs come together and reduce the risk of damage to the well casing.

[3] Sterrett, Robert J. 2007. *Groundwater and Wells-Third Edition.* Johnson Screens/a Weatherford Company., New Brighton, MN.P. 461-462

Grout Placement – When an Annular Space is Created by Use of a Driven Point

Construction by a driven point means a method of well construction that uses a solid point or cone that is driven into the ground. This does not include a cutting shoe unless a solid point is installed on an inner rod. This method is not machinery specific.

For example, the type of machinery that can be used to drive the solid point or cone into the ground can include direct push technology, rotary, percussion, pneumatic hammers, sonic, non-powered manual methods, and cone penetration testing equipment.

Creating and Sealing Annular Spaces of Driven Point Wells

The driving action during the installation of a driven point well pushes the formation to the sides of the point well and typically does not create a measurable annular space. However, excavations need to be created to connect the driven point well to the horizontal pipe (waterline). The horizontal pipe connects the driven point well to the building's plumbing. As part of backfilling these excavations, a suitable sealant needs to be placed from the bottom of the trench to within 20 cm (8″) of the ground surface (Note: for further information see Chapter 9: *Equipment Installation* and Figure 6-23 in this chapter). This suitable sealant also needs to be placed from the well casing a minimum distance outward of 20 cm (8″) in the excavation. The sealant placed in the horizontal pipe excavation (trench) around the well casing reduces the risk of surface water runoff and other near surface sources of contaminants from migrating down the outside of the well casing and impairing the well water.

For further information on backfilling trenches from driven point wells see Chapter 9: *Equipment Installation*.

If any annular space is created during the driving action, then the annular space must be sealed to prevent any movement of water, natural gas, contaminants or other material between subsurface formations or between a subsurface formation and the ground surface. In the case of a well constructed with the use of a driven point, any annular space created must be filled using a method and material approved by the Director.

To ensure that any annular space that may be present does not act as a pathway for contaminants to enter the well water and aquifer, the person constructing a well with the use of a driven point may create an annular space outside of the well casing on purpose and must fill it with suitable sealant. If this is the case, the person constructing the well could follow the best management practice that follows. If the person constructing a well with the use of a driven point proposes this or an alternative method, that person must write to the Director proposing how an annular space will be created and sealed around a well (see information provided after Figure 6-23). If the Director agrees with the approach, the Director will provide the person constructing the well with written approval to proceed with the method and materials.

Best Management Practice – A Method of Creating and Sealing Annular Space of a Well Constructed with the Use of a Driven Point

This Best Management Practice is shown in Figure 6-23 on page 53:

1. Excavate a hole below the frost line. This hole is part of a trench that will take the horizontal pipe (waterline) from the driven point well to the building's plumbing.

2. Below the excavated area, drive a well casing with a driven point (or a dynamic cone) that has an outside diameter of at least 11.75 cm (4 5/8″) into the water producing zone. The casing can be driven into the ground with machinery such as direct push technology or by manual methods.

3. Insert a driven point well screen and casing that has a diameter of about 6.7 cm (2 5/8″) into the well. Ensure the driven point well is centered in the 11.75 cm working casing.

4. Pull back the 11.75 cm diameter casing leaving the one-time use drive point in the well while:

   a) Filling the annular space around the screen portion of the drive point with a clean sand or gravel. The top of the sand or gravel should come no closer than 6 m (19.7′) below ground surface or 2.5 m (8.2′) below ground if the only useable aquifer necessitates a shallower well. Recognizing there is a potential for the sand or gravel to bridge due to the small diameter of the well and annular space, it is important to calculate the volume of the annular space around the screen and ensure the same volume of sand or gravel materials is placed into the well. Clean sand or gravel will also need to be poured slowly from the top of the annular space to prevent bridging.

   b) Filling the annular space above the sand or gravel by:

      i) Installing a tremie pipe to just above the sand or gravel. The casing portion of the well's annular space is filled with suitable sealant from the top of the well screen to the floor of the excavation using the tremie pipe and a grout pump. The suitable sealant will typically consist of at least 20 percent solids of sodium bentonite by weight.

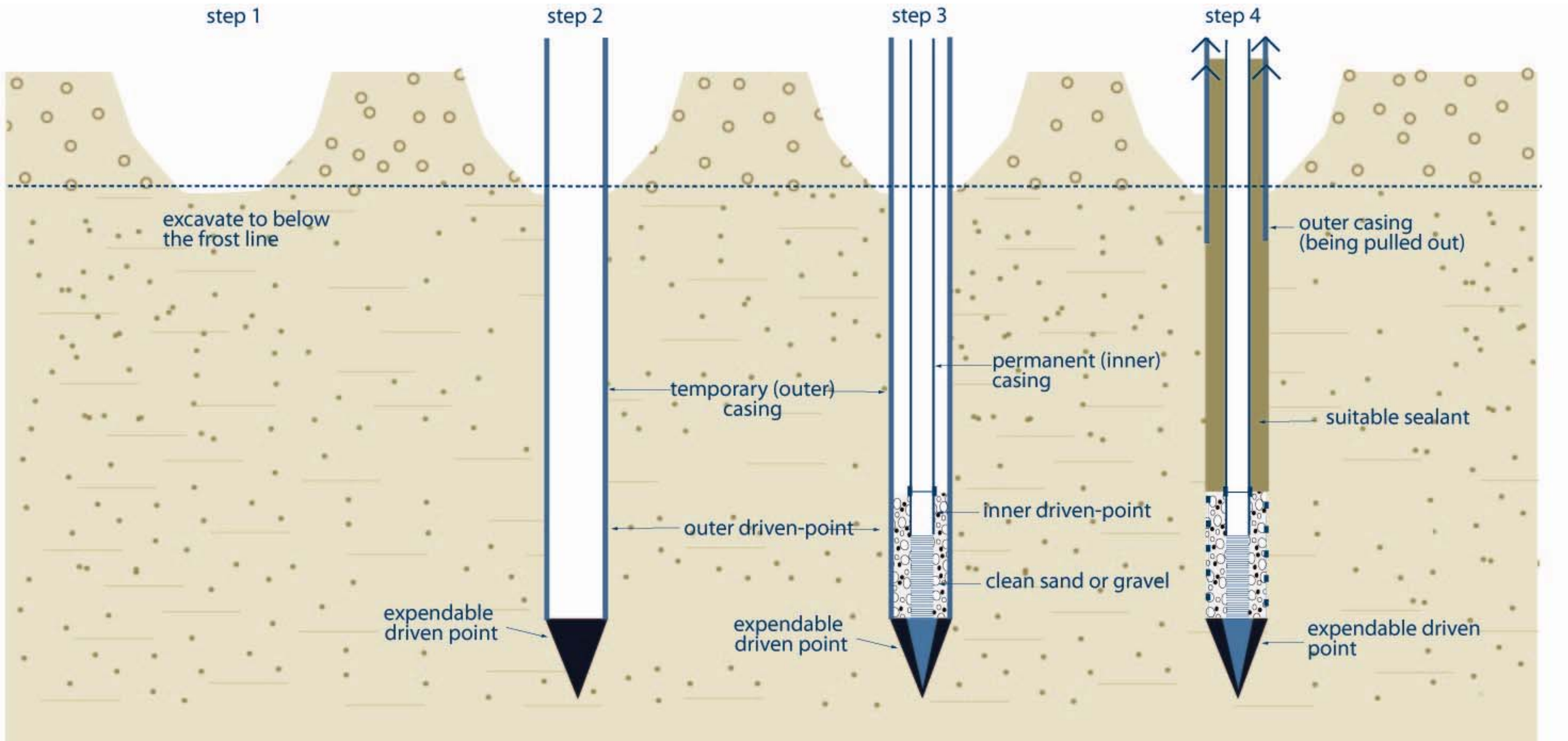
      OR

      ii) Placing sodium bentonite chips or pellets. Recognizing there is a potential for the bentonite chips or pellets to bridge due to the small diameter of the well and annular space, it is important to calculate the volume of the annular space and ensure the same volume of plugging materials are added to the well. Sodium bentonite chips and pellets should also be poured slowly from the top of the annular space to prevent bridging. At different intervals, the sodium bentonite chips or pellets will need to be hydrated with clean and potable water to allow the bentonite to expand in the annular space.

5. The filling of the well in the excavation should be completed as shown in Chapter 9: *Equipment Installation*.

For Steps 2 through 4, in the Best Management Practice above, different diameters of driven point wells can be used, however, it is important that the initial hole be at least 5 cm (2″) larger than the outer diameter of the final well casing to prevent bridging problems in the annular space.

FIGURE 6-23: SUGGESTED METHOD OF CREATING AND SEALING ANNULAR SPACE IN A DRIVEN POINT WELL



Step 4, a T-connection is installed on top of the casing to allow for the horizontal waterline to connect to the well. Additional casing is added on the well from the T-connection to above the ground surface and the trench is backfilled in accordance with the Wells Regulation (see Chapter 9: *Equipment Installation*).

Lining up the two points helps to centre the inner string. The inner driven point, in some cases, may rest on top of the initial point (e.g. if it is solid).

The diagram above is not to scale and is for illustrative purposes for this chapter only.

WHERE DOES THE PERSON CONSTRUCTING THE WELL HAVE TO GO TO SEEK A WRITTEN APPROVAL FROM THE DIRECTOR?

If the person constructing the well wishes to seek the written approval of the Director, that person may contact the Water Well Help Desk:

- Address of Water Well Help Desk, Environmental Monitoring and Reporting Branch of the Ministry of the Environment, 125 Resources Road, Etobicoke ON M8P 3V6;
- By telephone: 1-888-396-9355 (for Ontario residents only);
- By fax: 416-235-5960; or
- By e-mail: helpdesk@waterwellontario.ca

WHAT INFORMATION IS NEEDED FOR A WRITTEN APPROVAL?

Ontario

The Ministry assesses each case individually and on its merits. As a minimum, applicants contacting the Ministry for a written approval should provide a written request with the following information:

- The name of the individual(s)/entity that owns the well
- The location of the well
- The purpose and use of the well
- The reason for the sealant material and methods
- If applicable, written certification by the manufacturer/installer/professional engineer that the material and method will properly fill the annular space

The person constructing the well may be required to retain a *Professional Engineer or Professional Geoscientist* who would have to prepare a scientific report showing the appropriate scientific rationale to support the application. The person constructing the well would then have to submit the report along with the request for written approval to the Ministry for its consideration.

HOW DOES THE DIRECTOR'S DECISION PROCESS WORK?

The request for written approval should be submitted to the Ministry along with any and all supporting documents such as a hydrogeological and/or a well design report. The person constructing the well and others should be cautioned that obtaining a written approval will not be a simple and automatic process because the Ministry has to provide for the conservation, protection and management of Ontario's waters and for their efficient and sustainable use, to promote Ontario's long-term environmental, social and economic well-being.

The Ministry will review the request, supporting information and other information generated from internal and external parties with an interest in the application.

Based on the information, the Ministry will contact the person constructing the well in writing, indicating the Ministry has done any of the following:

- Issued the written approval to the person constructing the well
- Refused to issue the written approval and thus, requires the person constructing the well to use another prescribed option
- Requested additional information from the person constructing the well to allow the Ministry to make a decision

Tools for Annular Space & Sealing

Table 6-5 provides an example of the types of reference charts and tables that can be used to volumes of holes and casing.

Table 6-5: Calculating Casing and Hole Volume

Diameter		Volume			
Millimetres	Inches	Cubic metres/metre	Cubic feet/ft	US gal/ft	Imp gal/ft
51	2	0.002	0.022	0.161	0.134
64	2½	0.003	0.032	0.241	0.201
76	3	0.005	0.054	0.402	0.335
89	3½	0.006	0.065	0.483	0.402
102	4	0.008	0.086	0.643	0.536
114	4½	0.010	0.108	0.804	0.670
127	5	0.013	0.140	1.046	0.871
140	5½	0.015	0.161	1.206	1.005
152	6	0.018	0.194	1.448	1.206
165	6½	0.021	0.226	1.689	1.407
178	7	0.025	0.269	2.011	1.676
191	7½	0.029	0.312	2.332	1.944
200	7¾	0.031	0.334	2.493	2.078
203	8	0.032	0.344	2.574	2.145
216	8½	0.037	0.398	2.976	2.480
222	8¾	0.039	0.420	3.137	2.614
229	9	0.041	0.441	3.297	2.748
241	9½	0.046	0.495	3.700	3.083
248	9¾	0.048	0.517	3.860	3.217
254	10	0.051	0.549	4.102	3.418
279	11	0.061	0.657	4.906	4.088
305	12	0.073	0.786	5.871	4.893
311	12¼	0.076	0.818	6.112	5.094
324	12¾	0.082	0.883	6.595	5.496
381	15	0.114	1.227	9.169	7.641
438	17¼	0.151	1.625	12.144	10.120
445	17½	0.155	1.668	12.466	10.388
457	18	0.164	1.765	13.190	10.992
508	20	0.203	2.185	16.327	13.606
610	24	0.292	3.143	23.485	19.570
635	25	0.317	3.412	25.495	21.246
762	30	0.456	4.908	36.675	30.562
914	36	0.657	7.072	52.840	44.034

7. Completing the Well's Structure

Chapter Table of Contents

Chapter Figures

Chapter Description

This chapter covers the process and requirements for developing the well, venting the well, covering the well and affixing the well tag. Some of these tasks may take place in conjunction with, or following the installation of the pump. There are other requirements in completing a well construction operation that are not listed in this chapter as they do not relate to the structure of the well. For example a person constructing a well must complete and deliver a well record, show a water sample for visual examination, conduct a test of the well yield and shock chlorinate a well. These and other requirements are covered in the chapters following this chapter.

Regulatory Requirements – Completing the Well's Structure

Relevant Sections – The Wells Regulation

Well Pit – Subsections 12(7), 12(8)* and *12(9)

Well Pit Casing – Subsection 13(14)

Covering the Well – Section 12.2 and Subsections 15.2(6) to (8)

Surface Drainage – Section 12.3

Casing Height – Subsections 13(8), 13(9)* and *13(10)

Development – Section 14.8

Well Tag – Section 14.11

Venting – Subsection 15.1(1)

The Requirements – Plainly Stated

The Wells Regulation requires the following When a Person Completes Construction on a Well:

Covering the Well

If the well is left unattended during construction, the upper open end of the well must be covered securely to prevent entry of surface water and other foreign materials (for further information on well caps and covers see Chapter 9: *Equipment Installation*)

Mounding around the Well:

The ground surface must be properly mounded around the well to prevent any collection or ponding of water near the well.

Casing Extent for New Wells in Overburden Aquifers

A new well that obtains water from an overburden formation, must be cased:

- from the water intake zone,
- to at least 40 cm (16″) above the highest point on the ground surface within 3 m (10′) radially from the outside of the casing after the land is properly mounded for surface drainage as measured on completion of the well's structural stage.

Casing Extent for New Wells in Bedrock Aquifers

A new well that obtains water from a bedrock formation, must be cased:

- from the bedrock,
- to at least 40 cm (16″) above the highest point on the ground surface within 3 m (10′) radially from the outside of the casing after the land is properly mounded for surface drainage as measured on completion of the well's structural stage.

Casing Height Exemption for New Driven Point or Jetted Point Wells

An exemption to the minimum casing height requirement of 40 cm (16″) above the ground surface exists if the new well is made by the use of a jetted point or driven point and meets the following requirements:

- The well must be cased:
  - o from the highest point on the ground surface within a 3 m (10') radius of the well's casing after the land is properly mounded for surface drainage as measured on completion of the well's structural stage,
  - o to the water producing zone, if the well obtains water from the overburden or to the bedrock if the well obtains water from the bedrock
- The top of the casing must be a sufficient height above the ground surface to permit the attachment of a well tag.
- A permanent marker must be installed to identify the location of the well and be visible at all times of the year.

Well Pits

- A new well must not be constructed with a well pit (unless the new well is created by diamond drilling equipment in connection with mineral exploration)
- A well pit must not be added to an existing well (unless the existing well was created by diamond drilling equipment in connection with mineral exploration)
- If a new drilled well is constructed with a well pit, the top of the casing of the drilled well must be at least 40 cm (16″) above the floor of the well pit and the well pit must be cased:
  - o from the bottom of the well pit
  - o to at least 40 cm (16″) above the highest point on the ground surface within 3 m (10′) radially from the outside of the well pit casing after the land is properly mounded for surface drainage as measured at the time the well pit is completed.

All new well pits are banned in Ontario except for wells constructed by diamond drilling equipment that are also used in connection with mineral exploration. For further information on well pit installation see Chapter 9: *Equipment Installation*.

Well Caps or Covers

Dug or Bored

The top of the casing of a well that is constructed by digging or boring must be covered with a solid, watertight well cover, so that surface water and other foreign materials can not enter into the well.

Drilled or Other

The top of the casing of a well that is not constructed by digging or boring must be sealed with a commercially manufactured vermin-proof well cap (this includes a properly installed and sealed sanitary well seal and a watertight and airtight well cap for a point well).

Exceptions to Well Cap or Cover Requirements

The cover, cap or seal is not required if all of the following criteria are met:

- A floor has been constructed around or adjacent to the casing of the well
- A pump (including associated pump equipment such as a waterline attached to a pump) is installed above or adjacent to the well
- The top of the casing is shielded in a manner sufficient to prevent the entry of any material that may impair the quality of the water in the well, and
- The casing of the well is extended to at least 15 cm (6″) above the floor that has been constructed around or adjacent to the casing of the well.

See Chapter 9: *Equipment Installation* for further information on well caps and covers.

The Wells Regulation requires the following when Developing the Well:

Before the structural stage (see definition of well's structural stage in Chapter 2: *Definitions and Clarifications*, Table 2-1) of a new well is completed, debris (such as well cuttings, drilling fluids, etc.) must be removed from the well by developing the well until the well water is clear and free of sand.

The Wells Regulation requires the following when Venting the Well:

- When constructing a new well, the well must be vented to the outside atmosphere so that all gases will safely disperse from the well unless the casing is used to transmit water out of the well.
- Additional venting requirements may be required after pumping equipment is installed in the well

See Chapter 9: *Equipment Installation* for further information on venting.

The Wells Regulation requires the following regarding the Well Tag:

- Before the structural stage of a new cased well is completed, a well tag from the Ministry must be obtained and affixed permanently to the outside of the casing or to a permanent structure associated with the well. The affixed well tag must be visible and not hidden by the well cap and any other components of the well or equipment associated with the well.
- If an alteration, other than a minor alteration, is made to a cased well that does not already have a well tag, a well tag from the Ministry must be obtained and affixed before the alteration is completed as per the first bullet.
- If a cased well that already has a well tag is altered, the well tag must be safeguarded during the alteration and, if the well tag is removed, before the alteration is completed, it must be reaffixed as per the first bullet.
- If a broken, defaced, illegible or otherwise unusable well tag is encountered when altering the well, including a minor alteration, the person altering the well must:
  - Obtain a new well tag from the Ministry and, before the alteration is completed, affix it as per the first bullet, and
  - Return the original well tag and a completed well record with respect to the replacement of the well tag to the Director, within 30 days after the new well tag is affixed to the casing.

For more information on well tags, see Chapter 13: *Well Records, Documentation, Reporting & Tagging.*

Relevant Sections – Additional Regulations or Legislation

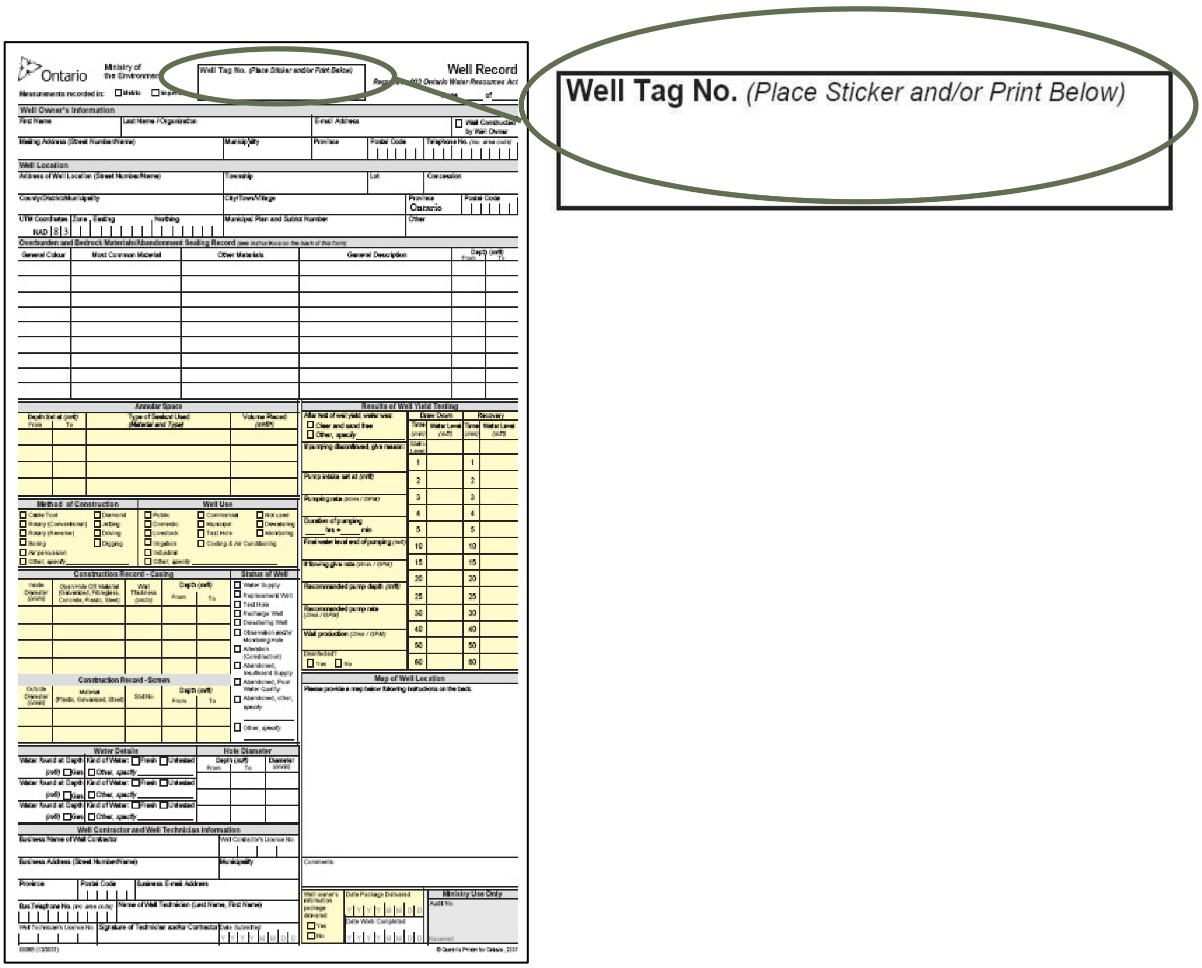
Ontario Water Resources Act, R.S.O. 1990, Chapter O.40 – Subsection 30(1)

Environmental Protection Act, R.S.O. 1990, Chapter E.19 – Subsection 14(1)

Well Record – Relevant Sections – Completing Construction

Figure 7-1 shows a sample of the details to be completed on the well record with regards to completing the well.

Figure 7-1: Well Record – Relevant Sections



KEY CONCEPTS

PURPOSE OF THE WELL

When completing the well's structure, it is important to consider the reason for the well installation. The purpose will impact how the structure should be completed. For example, a municipal well may have to be installed in a pump house without a well cover.

WELL DEVELOPMENT

The purpose of well development is to remove any water or drilling fluids introduced into the well during drilling, stabilize the filter pack and formation materials opposite the well screen, minimize the amount of fine-grained sediment entering the well and improve well efficiency and inflow of water into the well. Granular material (e.g. sand and silt) in the well water may have serious implications for the well owner's pumping equipment, waterline and plumbing.

CASING HEIGHT AND MOUNDING

A sufficient height of casing above the ground surface, or above the floor of a well pit, helps to prevent the entry of surface water or foreign materials through the top of the well. In addition, mounding of the ground surface immediately around the casing helps to prevent ponding of surface water at the well site and reduces the potential for surface water to migrate down the side of the well casing into the well.

WELL CAPS, COVERS AND SECURING THE WELL

Securing and covering the casing are the primary safeguards against unauthorized entry into the well, vandalism or tampering. They also protect against the movement of surface water or foreign materials from the surface into the well. Securing the well includes ensuring that the well cap, seal or cover is on properly and may include the use of a protective cover with locking cap, barriers or fences.

WELL TAG (IDENTIFICATION)

Well identification numbers link wells in the field with written records. The Ministry issues alphanumeric well tags that must be affixed to all new wells and many altered wells. The well tag is important as it links detailed information on the construction process and design of the well with the well in the field. This information is crucial to persons who have to:

- locate wells in the field,
- test and sample, and
- maintain, or if necessary, alter or abandon a well.

WELL DEVELOPMENT

Well development has four broad objectives:

1. To develop the well to a sand-free state as required by the **Wells Regulation.**
2. To stabilize the filter pack and formation materials opposite the well screen. Development creates a graded zone (i.e. natural sand and/or gravel pack with larger to smaller material away from the water intake zone) around the well screen in an overburden well (see Figure 7-2).
3. To correct damage to the hole wall and adjacent native geological material caused during construction.
4. To maximize the efficiency of the well and hydraulic connection between the well intake zone and the formation by decreasing the potential for lower porosity and permeability near and at the well intake.

These objectives are accomplished by applying some form of energy to the formation beside or below the well intake.

The **Wells Regulation** indicates that before the structural stage of a new well is completed, everything reasonably practicable must be done to remove any debris, including well cuttings and drilling fluids, from the well by developing the well until the well water is clear and free of sand.

Also, for any new well, other than a well constructed by digging or by the use of a jetted or driven point, where a well screen is installed, the well must be developed by a surging technique if the filter pack is created from native granular material.

"Clear" means all debris, including well cuttings and drilling fluids, has been removed from the well and well water; and the water is transparent or unclouded.

"Clear" does not mean without any naturally occurring colour associated with the well water.

For example, groundwater can turn an orange colour where naturally occurring iron is present in the groundwater and formation. Groundwater can turn a black colour where naturally occurring iron sulphide is associated with the groundwater. Both these samples could be "clear" for the purpose of well development requirements in the **Wells Regulation**.

Best Management Practice – Well Development

If all reasonable steps have been taken to develop the new well and it continues to produce water that visually has naturally occurring colour or sediment, drill cuttings or drilling fluids, it is important to notify the well purchaser and owner of the land that the condition exists to determine what next steps are necessary. With this information, the well purchaser and well owner can take the appropriate precautionary steps in designing, purchasing and installing pumping and treatment equipment in the well and water distribution system, or, if necessary, in abandoning and sealing the well.

Benefits of Well Development

In general, development procedures have the following beneficial purposes:

- protect the pumping equipment, waterline and plumbing from damage due to granular material (e.g. sand and silt) in the well water
- reduce the compaction and intermixing of grain sizes produced during construction by removing fine material from the pore space
- increase the natural porosity and permeability of the formation near the well intake by removing the finer grain material.

Specific to drilled wells:

Well Development:

- removes the filter cake or drilling fluid film that coats the hole, and removes much or all of the drilling fluid and natural formation solids that have invaded the formation during well construction,
- creates a graded zone (e.g. natural sand and/or gravel pack larger to smaller material) around the screen in an overburden well, so that the well yields sand-free water (see Figure 7-2), and
- Dislodges drill cuttings that may be plugging water bearing fractures in bedrock wells.

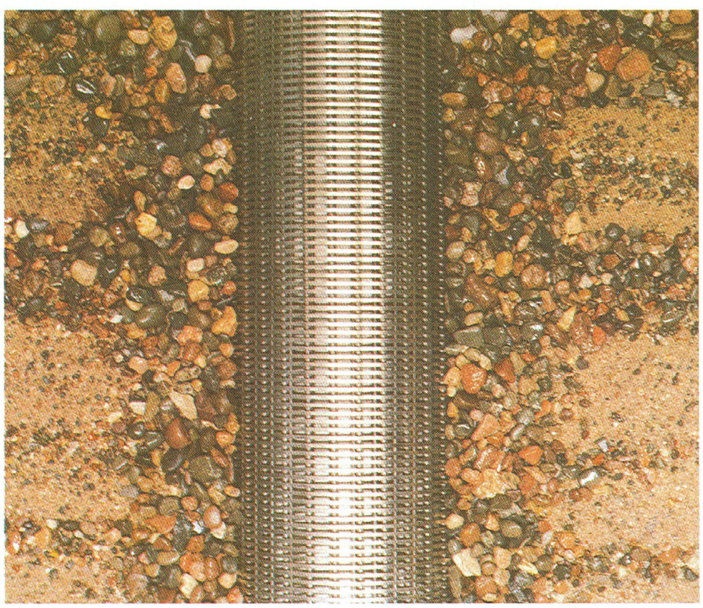


Figure 7-2: A Properly Developed Overburden Drilled Well[1]

Figure 7-2 shows how development (by surging water back and forth) has created a graded zone (i.e. natural sand and/or gravel pack with larger to smaller material away from the water intake zone) around the well screen in an overburden well

[1] Sterrett, Robert J. 2007. *Groundwater and Wells; Third Edition.* Johnson Screens/a Weatherford Company. New Brighton, MN. Fig.11.3, P 505

Development Methods

There are a great number of different factors that contribute to the method chosen to develop a well.

The selection of the appropriate development techniques must be based on:

- Equipment available and accessibility to the well
- Geology and hydrogeology (depth of aquifer in relation to well screen)
- Well construction system and method used (cutting action used, flushing media)
- Type of well installation (e.g. casing, annular space)
- Diameter and depth of the well
- Diameter, slot size and length of the well screen and the filter pack
- Hydraulic characteristics of the well
- Health and safety requirements for field staff
- Permit To Take Water, discharge approvals and other regulatory requirements

Well Development Techniques

Below is a list of some methods of well development for various scenarios. In some cases multiple techniques may be used to develop a well.

- Surging or Washing/Backwashing with plunger devices (forcing water to flow in and out of a well screen by operating a plunger up and down in the well)
- Air Lift Development (developing a well using an air lift to alternately surge and pump the well)
- Air Burst Development (a combination of pumping with air and using large bursts of air injected into the well screen or bedrock hole to surge the formation)
- Jetting (the use of high velocity jetting tools)
- Over-pumping (pumping at a higher rate than the well will be pumped when put into operation).
- Bailer Surging
- Hydrofracturing (hydrofracing) (bedrock well only)
- Freezing (bedrock well only)

Ontario

Any water introduced into the well during development or other well construction must not impair the quality of any well water or cause an adverse effect on the natural environment.

The container used to transport any water brought to the site for the well development must not contaminate the water in the container.

SURGING

One of the simplest and most common methods of development is Surging. The clay, silt and sand grains are agitated by rapidly moving a plunger up and down in the well. This action moves the water in and out of the formation and well screen as shown in Figure 7-3. Water containing fine granular material moves into the well casing. The granules tend to settle to the bottom of the well so they can be removed by pumping water or air or bailing.

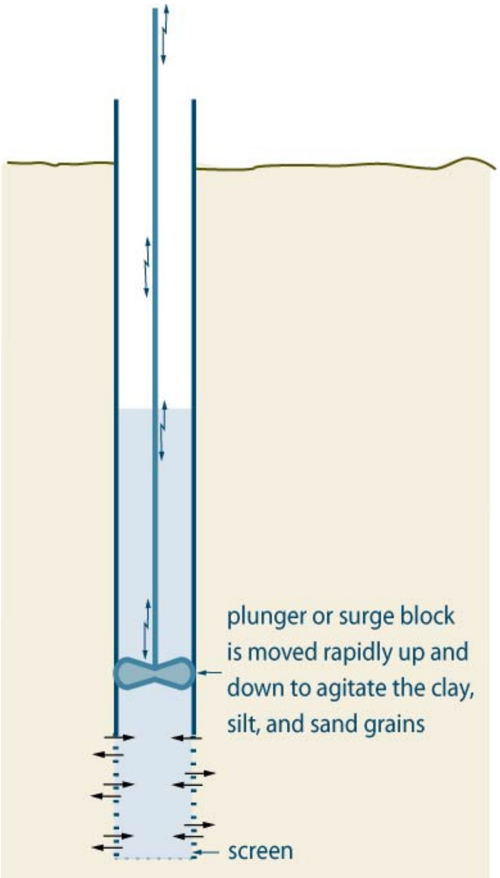


FIGURE 7-3: SURGING

The diagram above is not to scale and is for illustrative purposes for this chapter only.

All figures and diagrams are for illustrative purposes only and do not necessarily represent full compliance with other requirements found in the **Wells Regulation**.

AIR-LIFT PUMPING AND BACKWASHING

Another method available for developing a well is pumping with an air-lift pump at a high rate for a brief period, to draw water and formation fines into the well. Then the pump is shut off to "slug" the well, causing formation fines to loosen, and breaking sand bridges in the formation and filter pack.

Further information on well development can be found in *Groundwater and Wells: Third Edition*[2]

[2] Sterrett, Robert J. 2007. *Groundwater and Wells; Third Edition.* Johnson Screens/a Weatherford Company. New Brighton, MN.

Casing Height and Mounding

Mounding

Mounding the ground surface immediately around the casing helps to prevent ponding of surface water at the well site and reduces the potential for surface water to migrate down the side of the well casing into the well.

Ontario

The person constructing the well must ensure that the surface drainage is such that water will not collect or pond in the vicinity of the well.

Best Management Practice – Mounding

To prevent the pooling of water around the well, the following should be considered:

- In areas subject to frost heave, a soil or bentonite/sand layer should be placed adjacent to the casing and sloped to direct water drainage away from the well
- In areas not subject to frost heave (e.g. in a heated pump house), a concrete pad should be installed and sloped slightly to direct water drainage away from the well

CASING HEIGHT

The casing height must be checked at the completion of the well's structure to ensure it complies with the **Wells Regulation**.

For any new well, the casing height must be at least 40 cm (16″) above the highest point within a 3 m (10′) radius of the well's casing after the land is properly mounded for surface drainage as measured on completion of the well's structural stage. Figure 7-4 illustrates these measurements.

There are exemptions to the above well casing height requirement for a new well constructed by the use of a driven point or jetted point or with a well pit. For further information, see "Casing Height for New Point Wells Constructed by Driving or Jetting," on page 17 of this chapter and Chapter 9: *Equipment Installation*, "Well Pit Floor" section.

Best Management Practice – Casing Height

It is important to go beyond the minimum casing height requirement especially in areas prone to flooding such as a flood plain.

Special casing height considerations may have to be taken to vent gas from a well safely and keep the top of the casing above the top of the static water level in a flowing well.

To ensure a sufficient height of casing above the ground surface, it is also important to consider the proposed final grade of the property after landscaping.

Ontario

If a well casing extends to a height of 40 cm (16″) or more above the ground surface, the height of the casing cannot be reduced to a height of less than 40 cm (16″) above the ground surface. This includes cutting the casing or increasing the elevation of the ground surface adjacent to the well. Therefore, persons who work on pumps, developers, general contractors, landscapers and well owners should be aware of the minimum height of the well casing requirement above the land surface. If the land surface is raised, then the owner of the land or properly licensed person working on the well must extend the well casing to the minimum required height.

If work must be performed to raise the well casing, the person hired to do the work must have, or work for a business that has, a valid well contractor licence and have the proper prescribed class of well technician licence (see Chapter 3: *Well Construction Licences: Obtaining, Maintaining & Exemptions*).

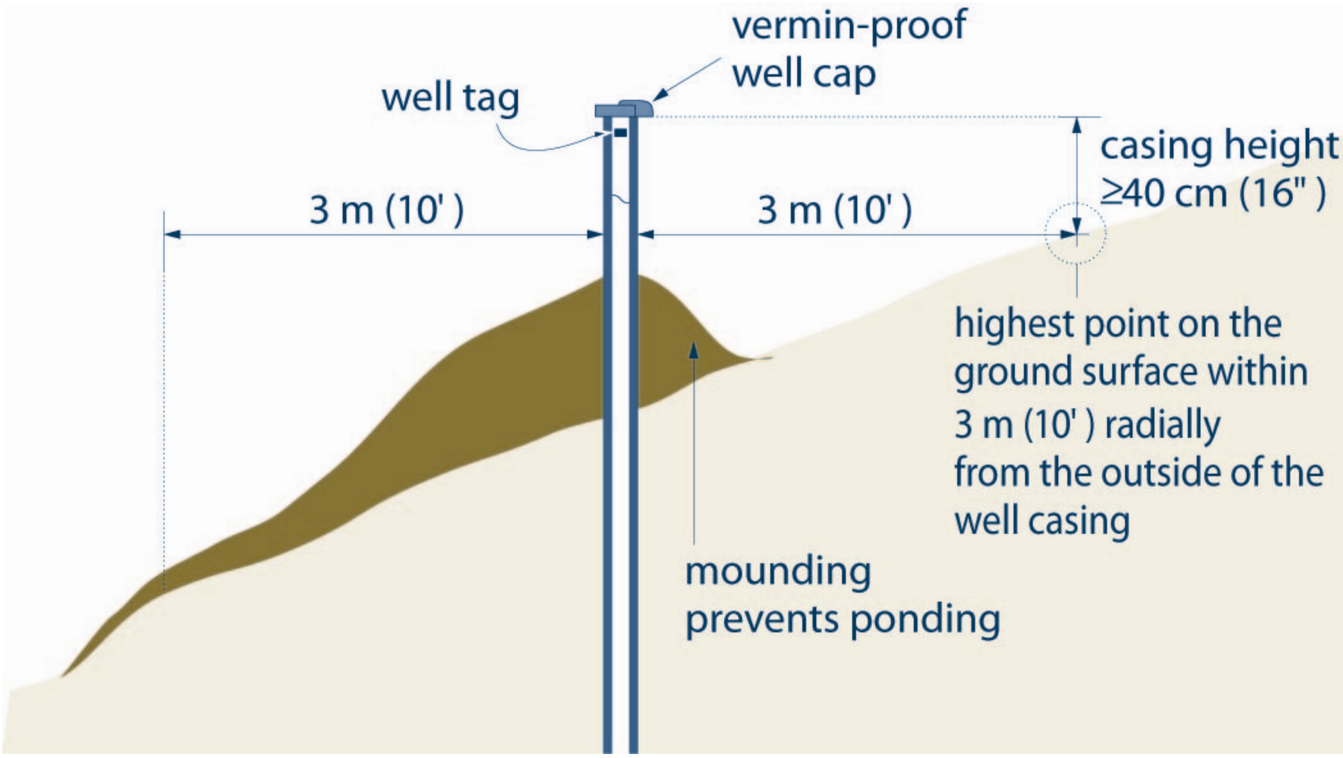


FIGURE 7-4: HOW TO MEASURE CASING HEIGHT ABOVE THE GROUND SURFACE FOR A NEW WELL (OTHER THAN A WELL CONSTRUCTED BY THE USE OF A JETTED POINT AND/OR DRIVEN POINT WITH A PERMANENT VISIBLE MARKER IDENTIFYING THE WELL)

The same method of measuring casing height applies to new jetted and driven wells that have been constructed with a permanent visible marker. In that case, the casing must extend a sufficient height to permit the attachment of the well tag and be at least as high as the highest point on the ground surface within 3 m (10′) radially from the outside of the well casing (see page 17 for further information).

The diagram above is not to scale and is for illustrative purposes for this chapter only.

All figures and diagrams are for illustrative purposes only and do not necessarily represent full compliance with other requirements found in the **Wells Regulation**.

Casing Height When Multiple Casings Are Used in a Well

In some cases, multiple casings of different diameters are installed in wells to reach a water producing zone. This type of installation is common in municipal wells, some flowing wells and other large water taking wells. For example the initial 20 m (65′) of the hole may have a 40 cm (16″) diameter casing. The next 20 m (65′) of the hole has a 30 cm (12″) diameter casing.

The overlapping zone between the inner and outer casing is considered an annular space and also a joint area. The overlapping zone between the inner and outer casing must meet all annular space requirements as outlined in the **Wells Regulation**. One of the casings must meet the required height standard of 40 cm (16″) or more above the ground surface.

Casing Height for New Point Wells Constructed by Driving or Jetting

Ontario

An exemption to the minimum casing height requirement of 40 cm (16″) above the ground surface exists if the new well is made by the use of a jetted point or driven point and it has a visible, permanent marker.

In these cases, the casing must:

- extend a sufficient height to permit the attachment of a well tag, and
- be at least as high as the highest point on the ground surface within a 3 m (10′) radius of the well's casing after the land is properly mounded for surface drainage as measured on completion of the well's structural stage.

The permanent marker must also identify the location of the well and be visible at all times of the year.

Best Management Practice – Casing Height for Driven or Jetted Point Wells

All wells including point wells should extend to at least 40 cm above the land surface for easier maintenance and identification purposes.

When extending the casing above the ground surface, the person constructing a point well should take the necessary steps in the design and installation to prevent water from freezing within the point well system.

Well Caps and Covers

Covering the Well

The **Wells Regulation** requires that if the well is left unattended during construction, the upper open end must be covered securely in a manner sufficient to prevent the entry of surface water and other foreign materials (for further information on well caps and covers see Chapter 9: *Equipment Installation*).

Dug or Bored

The top of the casing of a well that is constructed by digging or boring must be covered with a solid, watertight well cover, so that surface water and other foreign materials can not enter into the well.

In keeping with the description of watertight in Table 2-2 of Chapter 2: *Definitions & Clarifications*, a new one piece concrete or steel cover is considered to be watertight. A flat cover with an access lid on the top of the cover is not considered to be watertight because of the joint between the cover and access lid. A well cover is considered to be solid and watertight if it is constructed in a manner sufficient to prevent the entry of surface water and other foreign materials into the well.

See Chapter 9: *Equipment Installation* for graphics and further details on caps and covers.

Drilled or Other

The top of the casing of a well that is not constructed by digging or boring must be sealed with a commercially manufactured vermin-proof well cap. This includes a properly installed and sealed sanitary well seal commonly used in wells located in well pits and pump houses. This also includes a watertight and airtight well cap for a well that is constructed with the use of a well point.

See Chapter 9: *Equipment Installation* for graphics and further details on caps and covers.

Well Cap exemption for Drilled or Other

Every well, other than a dug or bored well must be fitted with a commercially manufactured vermin-proof well cap, unless all of the following criteria are satisfied:

- A floor has been constructed around or adjacent to the casing of the well
- The casing of the well is extended to at least 15 cm (6″) above the floor that has been constructed around or adjacent to the casing of the well
- A pump is installed above or adjacent to the well
- The top of the casing is shielded in a manner sufficient to prevent entry of any material that may impair the quality of the water in the well

See Chapter 9: *Equipment Installation* for graphics and further details on caps and covers.

VENTING THE WELL

When constructing a new well, the person constructing the well must ensure that the well is vented to the outside atmosphere so that all gases will safely disperse from the well.

The purpose of the vent is to allow the well to breathe, which enables pressures to equalize (e.g. when water is drawn out, air can enter the well keeping the column of water at atmospheric pressure). The vent also allows for the dispersal of natural gases to the outside atmosphere. In many cases, a properly designed vent is required to be installed on a well to safely disperse a gas that is poisonous, explosive or can cause another type of hazard. Additional information on venting is included in Chapter 9: *Equipment Installation*.

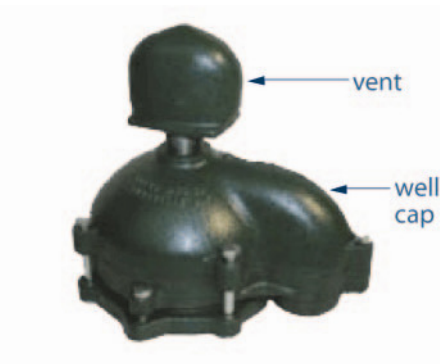


FIGURE 7-5: WATERTIGHT CAP WITH SCREENED AIR VENT ABOVE THE WELL CAP

When the vent is attached to the top of a well cap as shown in Figure 7-5, the vent can be extended a significant distance above the well cap to safely disperse any explosive or poisonous gases. This type of system can also elevate the vent above potential flood elevations to reduce the risk of flood waters entering the well through the vent.

SPECIAL CONSIDERATIONS FOR VENTING

FLOWING WELLS

- Flowing wells are not exempt from the regulatory requirement for venting unless the casing is used in some way to transmit water out of the well.
- A mechanical or inflatable packer, with a valve to allow air into and out of the well during pumping, may be installed to vent the well.

Wells Encountering Gas

Vents must be installed on the well at a sufficient height above the well to ensure the gas is safely dispersed at the well site to minimize risks from explosions and other adverse effects.

Where a well is constructed and natural gas is encountered, the person constructing the well must notify the well purchaser, the owner of the land, and the Director that the condition exists.

If a well is producing a natural gas or other gas and the gas is detected, the well owner must do the following:

- Take the necessary steps to manage the gas in a way that prevents any potential hazards,
- Properly abandon the well, or
- Seek the written consent from the Director to allow for the continued use of the well

Best Management Practice – Encountering Gas

Anyone constructing a well in an area known to have natural gas should consider retaining the services of a *Professional Engineer* or *Professional Geoscientist* experienced in groundwater and water wells producing naturally occurring gas. The *Professional Engineer* or *Professional Geoscientist* should take the following steps:

- Assess the well and the hydrogeology and geology around the well,
- Provide the owner with written recommendations,
- Confirm the recommendations have been implemented and are addressing the gas concerns at the site.

WELL TAGS

The **Wells Regulation** requires that before the structural stage of a new cased well is completed, a well tag from the Ministry be obtained and affixed permanently to the outside of the casing or to a permanent structure associated with the well. The affixed well tag must be visible and not hidden by the well cap and any other components or equipment associated with the well.

If an alteration, other than a minor alteration, is made to a cased well without a well tag, the person making the alteration must obtain and affix a Ministry well tag as described above, before the alteration is completed.

If a cased well that already has a well tag is altered, the well tag must be safeguarded during the alteration. If the well tag is removed before the alteration is completed, it must be reaffixed, as described above.

If an alteration, including a minor alteration, is made to a well with a well tag that is broken, defaced, illegible or otherwise unusable the person must:

- Obtain a new well tag from the Ministry and, before the alteration is completed, affix it to the well casing or a structure associated with the well
- Return the original well tag and a completed well record with respect to the replacement of the well tag to the Director within 30 days after the new well tag is affixed to the casing

Other requirements for the well tag include:

- The well tag must be securely and permanently attached to the well casing, or to a permanent structure associated with the well, so that it is clearly visible
- The well tag must be placed out of the way of the well cap and other equipment
- The well tag must be safeguarded throughout any work on the well
- The well tag must be permanently reattached before the job is finished if it is necessary to remove the well tag when working on a well
- A new well tag must be obtained and affixed and a new well record be completed and submitted to the Ministry when any work is done on a well that has a broken or unusable well tag
- The well tag must be removed from the well casing and returned to the Director within 30 days of removal when abandoning a well with a well tag

FIGURE 7-6: SAMPLE MOCK UP OF WELL TAG

For further information please see Chapter 13: *Well Records, Documentation, Reporting & Tagging*.

8. Well Disinfection

Chapter Table of Contents

Chapter Figures

Chapter Tables

CHAPTER DESCRIPTION

This chapter covers the importance of disinfecting pumping equipment and wells during initial construction, alterations and maintenance activities. It details the process required to comply with the **Wells Regulation**. Information on proper sampling and testing of water, safety issues and hazards is also provided.

REGULATORY REQUIREMENTS – DISINFECTION

RELEVANT SECTIONS – THE WELLS REGULATION

Ontario ***Disinfection – Section 15***

THE REQUIREMENTS – PLAINLY STATED

Ontario **The Wells Regulation requires the following:**

On the day the well's structural stage is complete, the person constructing the well shall:

- Remove all debris from the well
- Ensure:
  - The water in the well is dosed to a concentration between 50 mg/L and 200 mg/L of free chlorine and is left undisturbed for at least 12 hours.
  - The water in the well is not used for human consumption until the steps listed on page 8 are followed.
  - No further disinfection is required unless the water in the well is to be used for human consumption. If the water in the well is to be used for human consumption, the person must follow the requirements stated below.

Installing pumping equipment in a well or altering (other than a minor alteration) the existing well:

The person constructing the well must ensure the following steps set out in the **Wells Regulation** are taken:

- Dose the well water to a concentration between 50 mg/L and 200 mg/L of free chlorine (initial dose) as soon as possible after construction or installation of pumping equipment and all debris has been removed from the well.
- Test the well water for free chlorine residual at least 12 hours and not more than 24 hours after the water is chlorinated.
- If the test indicates the concentration of free chlorine residual in the well water is less than 50 mg/L or more than 200 mg/L, the person constructing the well must do the following steps, in the order shown below, as soon as reasonably possible:
    1. Pump the water out of the well until the concentration of free chlorine residual in the well water is less than 1 mg/L.
    2. Re-dose the well water to a concentration of not more than 200 mg/L of free chlorine.
    3. Test the well water for a free chlorine residual 12 to 24 hours later.
    4. If the test again indicates the concentration of free chlorine residual in the well water is less than 50 mg/L or more than 200 mg/L, repeat these steps again.
- If the test indicates the concentration of free chlorine residual in the well water is between 50 mg/L and 200 mg/L, the person constructing the well must do the following:
    - Pump the water out of the well until the concentration of free chlorine residual in the well water is less than 1 mg/L.

The Wells Regulation requires the following (continued):

Use of Well During Dosing and Testing

- In between dosing and testing, no person must disturb the well or use the water for any purpose.

Written Records of Test Results:

- The person who is responsible for ensuring that the water is tested for free chlorine residual must ensure the well purchaser is provided with a written record of the test results before the well is used as a source of water for human consumption.

Special Circumstances:

- The chlorination process after the initial dosing does not apply to an alteration of a well if all of the following are satisfied:
    - The alteration involves the urgent replacement or repair of a pump (including associated equipment) that unexpectedly failed,
    - No water supply is immediately available as an alternative to the water from the well, and
    - The well purchaser provides written instructions to the person who undertakes the well alteration to discontinue the disinfection process after dosing the well to a concentration not less than 50 mg/L and not more than 200 mg/L free chlorine.
- In these cases, the following is required:
    - The well purchaser must ensure that, before the well water is used for any purpose, water is pumped from the well until no odour of chlorine is detected in the well water.
    - The person who undertakes the alteration must retain the written instructions referred to above for two years.

Exemptions:

- The disinfection requirements do not apply to minor alterations, test holes, dewatering wells and flowing wells.
- The above disinfection requirements do not apply as long as the person constructing the well has written approval from the Director to use another method of disinfection and the approved method is complied with.
- These requirements do not apply to the replacement of a pump (including associated pumping equipment) that is installed above or adjacent to a well or in a well pit unless the replacement involves the removal of a well cover or well cap.

RELEVANT STANDARDS

American Water Works Association (AWWA). 2003. ANSI/AWWA C 654 -03 – "*Disinfection of Wells*." AWWA, Denver, CO. 2003. www.awwa.org

American Water Works Association (AWWA). 2006. ANSI/AWWA A100-06 – "*Minimum Requirements for Vertical Water Supply Wells*." AWWA, Denver, CO. 2006. www.awwa.org

NSF International Standard/American National Standard 60, 2009. "*Drinking Water Treatment Chemicals - Health Effects."* NSF International, Ann Arbor, MI 2009. www.nsf.org

The standards cited in this document are current at the time of printing. Check current documents for recent updates.

RELEVANT SECTIONS – ADDITIONAL REGULATIONS OR LEGISLATION

Ontario Regulation 169/03 as amended made under the *Safe Drinking Water Act*

WELL RECORD – RELEVANT SECTIONS – DISINFECTION

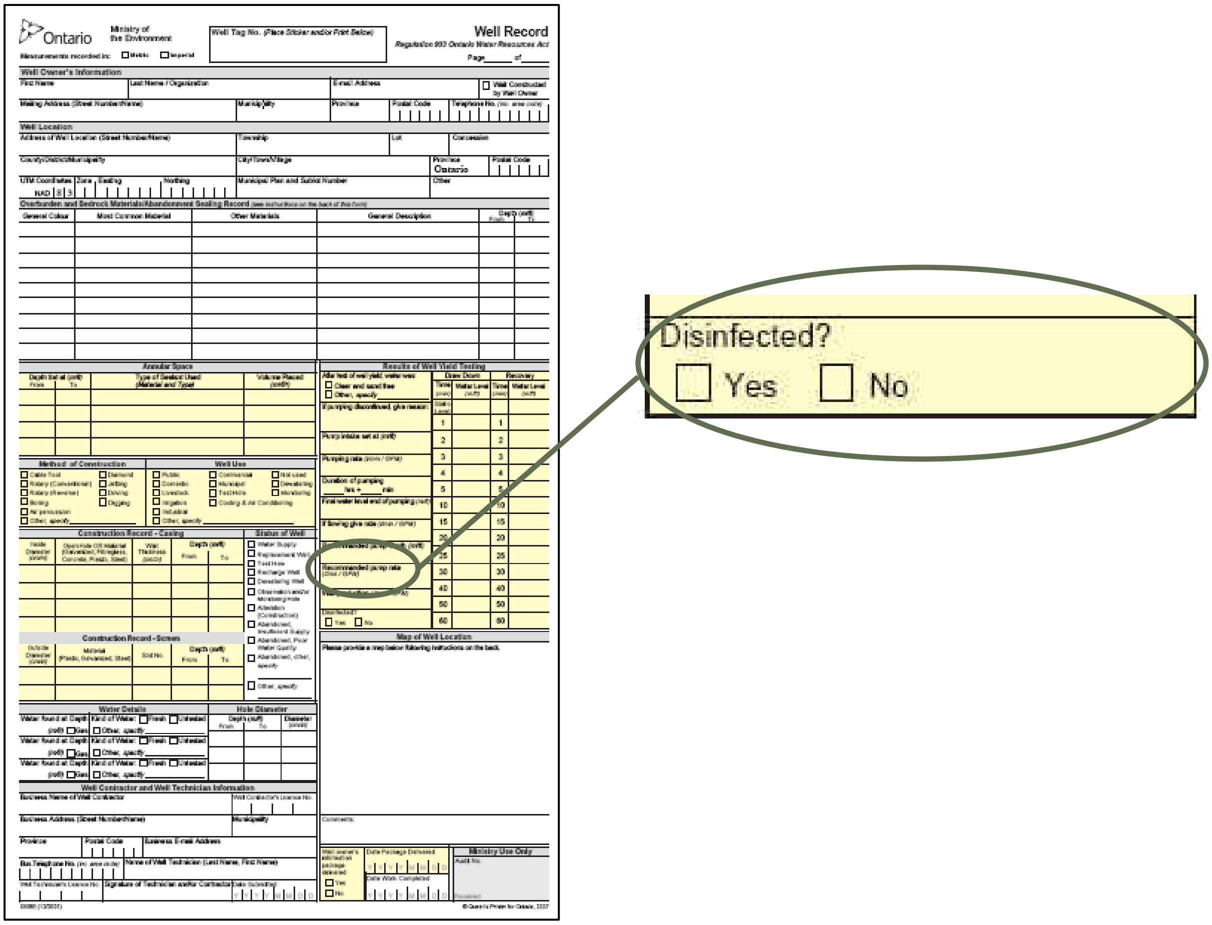
Ontario

Figure 8-1, below shows a sample of the details to be completed on the well record relating to disinfection.

By checking "Yes" in this section of the well record the person constructing the well is confirming that the disinfection requirements in the **Wells Regulation** have been followed.

A person can only select "No" in this section of the well record when exemptions to disinfection apply, such as flowing wells and minor alterations.

FIGURE 8-1: WELL RECORD – RELEVANT SECTIONS



Key Concepts

What to Consider When Disinfecting a Well

Purpose of Disinfection

The disinfection requirements in the **Wells Regulation** are to provide for the protection and management of Ontario's waters and for their sustainable use including human consumption.

The disinfection steps provide an adequate level of removal or inactivation of pathogenic organisms that may be present in the well or groundwater[1] or introduced during the well construction process and prevent heavily chlorinated water from impacting crops, surface water courses or other activities.

This chapter covers disinfection during and after well construction and installation of equipment in a well and does not include disinfection treatment (primary or secondary) on municipal distribution systems or treatment on private domestic water supplies.

Process of Disinfection

With respect to well construction and installation of equipment in a well, the process of disinfection involves the following[2]:

- Initial steps which include:
    - following sanitary practices when constructing a new well
    - properly developing a new well
    - removing any debris from a well
- Thorough flushing of the well
- Treatment with a properly prepared chlorine solution
- Discharge of heavily chlorinated water from the well and the plumbing
- Collection and analysis of water samples for indicator bacterial parameters

[1] The Ministry of the Environment. 2006. *Procedure for Disinfection of Drinking Water in Ontario*: Second Revision. p. ii. Available online: https://www.ontario.ca/drinkingwater/stel01_046942.pdf

[2] Holben, Ronald J., and Gaber, Michael R.S. 2003. *Michigan Department of Environmental Quality: Water Well Disinfection Manual*. Michigan DEQ, Lansing, MI. Available Online: http://www.deq.state.mt.us/wqinfo/swp/Disinfection_Manual.pdf P5

When Must Disinfection Take Place?

A well can become contaminated during well construction and pump installation.

While every effort should be made to keep the equipment used and the environment worked in contaminant free, the **Wells Regulation** requires that disinfection must be done after:

- Constructing a new well.
- Installing, including re-installing, the pumping equipment in a well.
- Deepening or extending a well.
- Conducting other alterations or repairs on an existing well or on equipment in a well except minor alterations.

The above does not apply to flowing wells.

Use of Chlorinated Water in the Disinfection Process

To make water safe to drink, chlorine, in its various delivery forms, is generally a good disinfectant for indicator organisms and most pathogenic organisms. Treatment with chlorine products is an inexpensive and effective way to disinfect the pumping system and the well water. Although chlorinating the water is a good treatment for a well and pumping equipment, its effectiveness depends on a number of factors, including:

- **Form** – The most effective form of chlorine solutions for dosing well water is liquid sodium hypochlorite (such as unscented bleach). When used properly it is the easiest to mix and will best provide the concentration of at least 50 mg/L and not more than 200 mg/L of free chlorine throughout the column of water in the well.

  Granular calcium hypochlorite is another choice but it is difficult to mix with water. It is best to avoid the use of chlorine puck or tablet products to dose the well as they can become lodged in the well, can corrode the equipment and may not provide the proper concentration for the required amount of time. It is also best to avoid the use of chlorine products used for swimming pools as they typically contain other chemicals such as algaecides and surfactants.
- **Chlorine concentration** – The **Wells Regulation** requires a dose to create a free chlorine of at least 50 mg/L (0.007 oz/gal) and not more than 200 mg/L (0.032 oz/gal). This range is based on recommendations provided by Ontario's Advisory Council on Drinking Water and Testing Standards.
- **Free chlorine residual** – It is the amount of chlorine available that acts as an oxidizer (kills micro-organisms). The free chlorine is comprised of hypochlorous acid (HOCl) and hypochlorite ion (OCl^-) that is not combined with ammonia (NH_3) or other compounds in water. (See page 24 for further details).

- **Contact time** – The longer the microorganisms are in contact with the free chlorine, the more effective the disinfection. The **Wells Regulation** requires a minimum contact time of 12 hours, but not more than 24 hours[3].
- **Agitation –** Dosing a well by pouring a chlorine solution into a well is not enough to ensure it is completely mixed to the required concentration. To ensure the free chlorine residual is at the correct concentration throughout the entire water column, well water should be agitated while avoiding the suspension of sediment from the bottom of the well into the water column.
- **pH of water** – The effectiveness of free chlorine is maximized at pH levels between 6.0 and 7.0.[4] As chlorine solutions are highly alkaline (i.e. high pH), the dose of chlorine solution in the well increases the pH of the well water and can diminish the effectiveness of the free chlorine. Therefore, it is important to follow the 50 mg/L to 200 mg/L concentration range requirements for free chlorine set out in the **Wells Regulation.**
- **Temperature –** The effectiveness of free chlorine can change with temperature. Free chlorine is more effective at higher temperatures.
- **Interfering substances –** Available chlorine will be used up by any inorganic and organic compounds in the well water which will reduce the concentration of free chlorine.
- **Biofilm** - Biofilm is a slimy substance that attaches to sides of wells and pumping equipment. The slime consists primarily of nuisance microbes (e.g. iron oxidizing bacteria and sulphate-reducing bacteria) that can shield pathogens from the oxidizing action of the free chlorine and reduce the amount of available chlorine. Therefore, it is necessary that biofilm be removed before treating the well water with free chlorine.

[3] American Water Works Association (AWWA). 2003. ANSI/AWWA C 654 - 03 – *"Disinfection of Wells."* AWWA, Denver, CO. 2003. www.awwa.org Section 4.5.1, P5.

[4] Holben, Ronald J., and Gaber, Michael R.S. 2003. *Michigan Department of Environmental Quality: Water Well Disinfection Manual*. Michigan DEQ, Lansing, MI. Available Online: http://www.deq.state.mt.us/wqinfo/swp/Disinfection_Manual.pdfP22

INITIAL STEPS FOR NEW WELLS

SANITARY PRACTICES

Preparing the water supply for new wells begins with adopting sanitary practices to prevent contaminants from entering the well during construction. This is done by following sanitary practices during storage, transport, handling and installation of well components and equipment. Essentially, anything that comes into contact with the water in the well can potentially introduce contaminants in the well.

Each of the scenarios listed below presents a potential cause of contamination to a well:

- Pumping equipment laid on a lawn that has recently been fertilized
- Pumping equipment laid on a lawn that has potential pathogens from soil and animal waste
- Construction equipment that has been dragged through a field where cows or other domestic animals graze
- Contaminated sand or gravel filter pack material that will be installed around a well screen
- A storage tank that recently held contaminated water
- A faulty well cap that can act as a direct pathway for foreign materials to enter the well
- An unsealed or ungrouted annular space outside the casing allowing a pathway for surface water runoff to enter the well
- Improper use of grease, lubricants and drilling additives during construction that can promote bacterial growth[5]
- Using contaminated water from ponds, rivers and lakes in the construction process

[5]. American Water Works Association (AWWA). 2003. ANSI/AWWA C 654 - 03 - *"Disinfection of Wells."*. AWWA, Denver, CO. 2003. www.awwa.org Section 4.1, P2.

Best Management Practice – Preventing Contamination During Storage and Transportation

To prevent contamination during storage and transportation of well components, adopt the following procedures:[6]

- Keep water supply equipment and construction materials off the ground by placing them on clean sheeting
- Ensure vehicles that transport the equipment and materials are clean
- Cover equipment and materials on vehicles to protect them from road dirt and grit
- Keep the components and materials in their wrapping or boxes until just before use if the components and materials have been wrapped or boxed by the manufacturer

Best Management Practice – Preventing Contamination During Construction

To prevent contamination from construction equipment or materials that will come in contact with the water adopt the following best practices:

- Clean and sanitize all equipment such as drill bits, drill rods or backhoe shovel with chlorinated water that has a free chlorine residual of not less than 200 mg/L[7]
- Use an approved potable water supply (e.g. municipal water trucked in to the site) during the construction process. The potable water source should have a free chlorine residual of at least 10 mg/L to suppress bacterial growth[8]
- Put water used in the construction process in clean containers[9]
- Keep all equipment off the ground by placing it on clean tarps or on the drilling rig until needed
- Avoid dragging the equipment on the ground
- Avoid contaminating the drilling mud or water with additives that may promote bacterial growth
- Avoid using excessive amounts of grease on drill rod tool joints.

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[6] Holben, Ronald J., and Gaber, Michael R.S. 2003. *Michigan Department of Environmental Quality: Water Well Disinfection Manual*. Michigan DEQ, Lansing, MI. Available Online: http://www.deq.state.mt.us/wqinfo/swp/Disinfection_Manual.pdf. P6.

[7] American Water Works Association (AWWA). 2003. ANSI/AWWA C 654 - 03 - *"Disinfection of Wells."*. AWWA, Denver, CO. 2003. www.awwa.org Section 4.4, P4.

[8] Holben, Ronald J., and Gaber, Michael R.S. 2003. *Michigan Department of Environmental Quality: Water Well Disinfection Manual*. Michigan DEQ, Lansing, MI. Available Online: http://www.deq.state.mt.us/wqinfo/swp/Disinfection_Manual.pdf Pp7-8.

[9] Holben, Ronald J., and Gaber, Michael R.S. 2003. *Michigan Department of Environmental Quality: Water Well Disinfection Manual*. Michigan DEQ, Lansing, MI. Available Online: http://www.deq.state.mt.us/wqinfo/swp/Disinfection_Manual.pdfPp 7-8.

Disinfection for Sand or Gravel (Filter Pack)

For details on installing sand or gravel (filter pack) in a well – See Chapter 5*: Constructing & Casing the Well.*

In addition to keeping materials clean during storage and transportation, a person installing sand or gravel (filter pack) during well construction should: [10]

- Avoid, if possible, buying the material in bulk and storing it on-site to reduce the risk of exposing the material to sources of contamination such as soil bacteria, insects and animal feces
- Ensure the sand or gravel are free of all organic materials to reduce the potential for bacterial growth
- Saturate the sand or gravel (filter pack) using chlorinated water with a free chlorine residual of at least 50 mg/L or a mixture of calcium hypochlorite tablets at a ratio of 113 g (¼ lb) to 227 g (½ lb) to a 22.7 kg (50 lb) bag of sand or gravel

The use of calcium hypochlorite tablets in hard water environments (hardness in excess of 100 mg/L) should be discouraged as this form is very slow to dissolve in the water. The condition will result in low levels of free chlorine over extended periods of time which may account for low levels of disinfection by-product formation. The situation becomes more critical in private wells which are subject to limited pumping and long periods of inactivity.

The use of calcium hypochlorite tablets in hard water environments (hardness in excess of 100 mg/L) should be discouraged as this form is very slow to solubilize in the water. The condition will result in low levels of free chlorine over extended periods of time which may account for low levels of disinfection by-product formation. The situation becomes more critical in private wells, which are subject to limited pumping and long periods of inactivity.

Well Development

Proper well development is required to remove fine soils, drilling fluids and drill cuttings from the well and surrounding formation. See Chapter 7: *Completing the Well's Structur*e, for further details on well development.

[10] American Water Works Association (AWWA). 2003. ANSI/AWWA C 654 - 03 - *"Disinfection of Wells."*. AWWA, Denver, CO. 2003. www.awwa.org Section 4.3, p. 3, and
Holben, Ronald J., and Gaber, Michael R.S. 2003. *Michigan Department of Environmental Quality: Water Well Disinfection Manual*. Michigan DEQ, Lansing, MI. Available Online: http://www.deq.state.mt.us/wqinfo/swp/Disinfection_Manual.pdf Pp 9-9.

INITIAL STEPS FOR EXISTING WELLS

During the alteration of an existing well or the installation of a pump (and related equipment) there is the potential for pathogens to be introduced into the well. Disinfection must occur to remove pathogens from the well. Scaling, biofilm and other debris is commonly present on the side of the well or the equipment and in the well water. This organic and inorganic matter can reduce the available free chlorine. Biofilm can also shield pathogens from the oxidizing action of the free chlorine.

To properly prepare an existing well for chlorination and other disinfection methods, all factors that can influence the effectiveness of the process must be minimized. The following steps should be followed[11]**:**

- Remove:
    - Any debris in the bottom of the well
    - Scale on the sidewalls of the casing
    - Slime buildup from biofouling organisms
- Evaluate and repair well construction deficiencies or problems, including but not limited to:
    - Buried wellhead with well seal that can become compromised over time and create a direct pathway for contamination
    - Vandalized wellhead introducing contamination or allowing surface water and other foreign materials to enter the well
    - Unprotected horizontal water intake line (pipe) that develops leaks due to physical damage or corrosion
    - Open horizontal water intake line (pipe) that is a direct pathway between the near surface and the well
    - Damaged or compromised well cap, cover or seal allowing surface water and other foreign materials to enter the well
    - Deteriorated, cracked or compromised casing due to physical damage or corrosion (e.g. oxidization, electrolysis) that has created openings and may allow surface water or other foreign materials to enter the well
    - Improperly sealed or unsealed annular space or eroded sealant in the annular space creating a direct pathway to the well
    - Potential re-contamination from improperly abandoned wells on site
    - Openings between the electrical conduit and the well cap allowing foreign materials, insects and other vermin to enter the well
    - Cross connections that allow unwanted backflow to enter the well
    - Well vent improperly placed, screened or sized may allow foreign materials, insects and other vermin to enter the well
- Clean the well including:[12]
    - Scrubbing the inside of the casing with a swab, packer, brush or similar device

[11] Holben, Ronald J., and Gaber, Michael R.S. 2003. *Michigan Department of Environmental Quality: Water Well Disinfection Manual*. Michigan DEQ, Lansing, MI. P14.

[12] Holben, Ronald J., and Gaber, Michael R.S. 2003. *Michigan Department of Environmental Quality: Water Well Disinfection Manual*. Michigan DEQ, Lansing, MI. Pp16-17.

- Removing debris from the bottom of the screen or hole with an air line, bailer or other method
- Removing suspended materials in the water by pumping the well water until it runs clear. The discharged water should be collected and disposed of in an approved manner or discharged to waste in an approved manner

If the building's plumbing also needs to be disinfected, a person should turn off and completely drain distribution waterlines, water heaters and storage tanks.

Carbon filters, water softeners and other treatment units on the plumbing should be removed or bypassed. Highly chlorinated water can damage treatment units. It is important to follow the manufacturer's recommendations to ensure treatment systems are properly disinfected.

THOROUGH FLUSHING OF THE WELL (NEW & EXISTING)

Flushing is the process of pumping out the water to help rid the well of contaminants and debris. The scouring action of the moving water assists in removing scaling and biofilm from the sides of the well. This process should be used to prepare the well before chlorine treatment and after to remove the chlorine residual from the well after treatment.[13]

This section discusses flushing prior to chlorination (see the process beginning on page 53 for flushing of the well after chlorination).

Best Management Practice – One Method of Flushing the Water Supply

The following steps should be considered when undertaking a flushing of a well:

- Installing the pump as close to the bottom of the well as possible to assure movement of the entire water column and removal of debris.
- Taking care to install the pump intake above the top of the well screen.
- Moving the pump intake up and down in the well column, in some wells, as this will help with cleaning the sides of the well and removing material.
- Maximizing the pumping rate will provide a more effective flush. Care should be taken not to exceed the well's capacity which could cause damage to the pumping equipment and to the formation around the well.
- Flushing low capacity wells with injected potable water to clean the well out and remove contaminants
- Pumping the well as long as possible. If the well has the capacity, pumping a minimum of 20 volumes of the water column in the well is recommended[14].
- Discharging or collecting and disposing of discharge water in an approved manner. Discharge water should not be disposed of in any river, lake, stream, wetland, septic system, pond or ditch.
- Taking care to prevent flooding of property and roadways.

[13] Holben, Ronald J., and Gaber, Michael R.S. 2003. *Michigan Department of Environmental Quality: Water Well Disinfection Manual*. Michigan DEQ, Lansing, MI. P18.

[14] Holben, Ronald J., and Gaber, Michael R.S. 2003. *Michigan Department of Environmental Quality: Water Well Disinfection Manual*. Michigan DEQ, Lansing, MI. P18.

Treatment Using "Shock" Chlorination

The simplest and one of the more effective ways to disinfect well equipment and the well water is to use a chlorine solution. The oxidizing action of the chlorine solution kills bacteria, viruses, protozoans and some protozoal cysts.

"Shock" chlorination is an effective treatment method that is done after the initial steps of developing, cleaning and flushing the well to eliminate pathogens.

Free chlorine degrades rapidly in the natural environment and as such an approval from the Ministry of the Environment is not required to disinfect a well with hypochlorite.

Forms of Chlorine for Disinfection

1. Sodium hypochlorite (such as Household Bleach)

Sodium hypochlorite is commonly found in products like household bleach and swimming pool disinfection products. It has a yellow colour and a chlorine smell. Household bleaches typically contain 3 to 6 percent available chlorine. Industrial strength commercial bleach and swimming pool products can contain 10 to 12 percent available chlorine. However, the use of swimming pool products is not recommended because they typically contain additives that may impair the quality of the well water.

Household bleaches containing sodium hypochlorite are routinely used in domestic wells and are recommended in chlorination treatment because:

- They are familiar and common household products
- Calculating, measuring and mixing the required volume of liquid to achieve the required dose is less complicated than for other products (e.g. powders, tablets or pucks)
- They are safer to use than liquid chlorine, chlorine gas or calcium hypochlorite

However, only regular, unscented major brand bleach products should be used as the greater percentage of bleach products on the household market contain silicates, surfactants, silicon and/or thickeners. All of these additives will harm both the water quality and the performance of the water supply (also see the notes at the bottom of the page).

The unstable nature of sodium hypochlorite makes it sensitive to temperature and light and therefore it has a limited shelf life. For example, sodium hypochlorite degrades extremely rapidly in the hot, sunlit cab of a truck. Carrying and purchasing small containers ensure a fresh supply for each well construction project.

Sodium hypochlorite products are described as weight % of available chorine, weight % of sodium hypochlorite and trade percent. To convert to weight % of available chlorine from trade percent and sodium hypochlorite use the following:

- Trade Percent = grams per litre (gpl) of available chlorine / 10

  Weight % of available chlorine = gpl / 10 x specific gravity of solution

  Weight % of available chlorine = Weight % of sodium hypochlorite / 1.05

All chlorine products utilized for potable water use must be either fresh unscented bleach or must meet the NSF International Standard 60 for Drinking Water Treatment Chemicals – Health Effects, or an equivalent standard

- Avoid using scented bleach or products such as swimming pool chlorine that typically contain additives such as surfactants, thickeners, stabilizers, perfumes, UV inhibitors, algaecides or other additives as they can impair the quality of the water and aquifer after disinfection and are not designed for potable water use
- Always check product labels to verify product contents and manufacturer's suggested usage as well as Material Safety Data Sheets (MSDS) (see "Safe Handling of Chlorine", pg.26.)
- Chlorine products should always be stored in a cool, dry and dark environment

2. Calcium Hypochlorite (Dry – Powder, granules or tablets)

Calcium hypochlorite is a white granular compound containing about 60 to 70 percent available chlorine that is fairly stable when stored in a cool dry place. Calcium hypochlorite is available as granules, powders, tablets and pucks.

Calcium hypochlorite is not typically recommended for the following reasons:

- Calculations can be difficult with such a high concentration.
- The high potency and required agitation can cause difficulties and requires greater safety precautions when handling and using products.
- Tablets should be avoided as they are slow to dissolve and may become lodged within the parts of the well and pumping components. If tablets are used, they must first be broken up and dissolved into a 20 litre (4 gallon) pail or tank.
- In limestone, marble and other calcium-rich environments calcium hypochlorite can increase the concentration of calcium in already hard groundwater causing partial plugging of well intakes, screens and water-bearing fractures[15].

Care must be taken when selecting this product to ensure that it is approved for use in potable water and meets all applicable standards such as ANSI/AWWA B300 titled: AWWA "*Standard for Hypochlorites*"[16] and the NSF International Standard for "*Drinking Water Treatment Chemicals – Health Effects*[17]."

[15] Holben, Ronald J., and Gaber, Michael R.S. 2003. *Michigan Department of Environmental Quality: Water Well Disinfection Manual*. Michigan DEQ, Lansing, MI. P21.

[16] American Water Works Association (AWWA). 2004. ANSI/AWWA B300 - 04 - "*Hypochlorites*." AWWA, Denver, CO. 2003. www.awwa.org

[17] NSF International Standard/American National Standard 60, 2009. "*Drinking Water Treatment Chemicals - Health Effects,*" NSF International, Ann Arbor, MI 2009. www.nsf.org

Effectiveness of Chlorine

Free Chlorine Residual

When a chlorine solution is first added to water (i.e. when the well is dosed) the available chlorine will react with substances in the water, and on the surfaces inside the well. During this reaction, some of the available chlorine is used up by organic and inorganic matter and can no longer kill pathogens and disinfect the well. The remaining available chlorine is the free chlorine residual that can effectively react to any pathogens. Free chlorine residual consists of two main compounds: hypochlorous acid (HOCl) and hypochlorite ion (OCl^-). Hypochlorous acid is much more effective (80 to 200 times better) at killing pathogens than the hypochlorite ion.

Substances that Interfere with the Effectiveness of Free Chlorine Residual

Available chlorine will be used up by any inorganic and organic compounds in the well water which will reduce the concentration of free chlorine. Examples of common materials or properties that reduce the free chlorine concentration are:

- Alkalinity
- Hydrogen sulphide (H_2S)
- Methane (CH_4)
- Iron
- Manganese
- Biofilm (iron oxidizing bacteria and sulphate-reducing bacteria)
- Silt
- Clay

Therefore, additional cleaning of the well or additional chlorine solution may be needed to meet the required free chlorine residual concentration range in the **Wells Regulation** (not less than 50 mg/L to not more than 200 mg/L).

Well Structure

In some cases the geologic environment and well structure play a role in the amount and placement of the chlorine dose. For example, injecting and mixing of the dose by a surge block is more appropriate in a well screen, whereas a jetting tool may be more appropriate in an open bedrock hole. Also, large open fractures in open bedrock wells may allow the calculated chlorine solution to move further away from the well requiring more chorine solution to maintain the required free chlorine residual in the well.

pH Levels

Sodium hypochlorite (bleach) and calcium hypochlorite are alkaline (caustic). It is important to note that as these chlorine products are added to water, the pH will increase. The form of free chlorine residual is pH-dependent. High pH environments create more hypochlorite ions and significantly reduce the effectiveness of the treatment. Therefore, it is important not to use too high of a concentration of these chlorine products. Hypochlorous acid production and thus, the effectiveness of free chlorine are maximized at pH levels between 6.0 and 7.0.[18]

Best Management Practice – Adjusting the pH of the Chlorine Solution[19]

It is important to control the pH to maximize the amount of hypochlorous acid available to kill pathogens. There are several commercial acid products on the market that can lower the pH of water that will be used to make the chlorine solution. Any of the acid products used in the process must not impair the quality of the water in the well or the aquifer and should meet NSF International Standards for potable water or an equivalent standard. Carefully follow the manufacturer's instructions when adding any acids to the water. Acid should be added to water in a storage tank to lower the pH to 4.5 to 5.0 [20] followed by adding a hypochlorite solution. A formula for distilled white vinegar is found on page 44.

Recommended acids include:

- Acetic Acid (distilled white vinegar only)

Acids to avoid include:

- Oxalic Acid – dangerous to skin and eyes and produces oxalates which are poisonous
- Citric Acid – food source for bacteria and difficult to get out of a well
- Muriatic (Hydrochloric) Acid – hazardous to handle
- Phosphoric Acid – leaves phosphate residue behind

CAUTION! Never add acid directly to a hypochlorite solution (e.g. bleach) as chlorine gas can be formed. Avoid exposure to the fumes from the acid container.

When acid has been added to the water to lower the pH below 5 followed by adding a hypochlorite solution, some chlorine gas will be produced. The chlorine gas will be produced for a short period of time until the hypochlorite raises the chlorine solution's pH above 5. Chlorine gas is toxic. Therefore, add the acid source to the water and then the hypochlorite solution only in a well ventilated area (see the section titled: "Safe Handling of Chlorine and Other Chemicals" page 26).

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[18] Holben, Ronald J., and Gaber, Michael R.S. 2003. *Michigan Department of Environmental Quality: Water Well Disinfection Manual.* Michigan DEQ, Lansing, MI. P 22

[19] Holben, Ronald J., and Gaber, Michael R.S. 2003. *Michigan Department of Environmental Quality: Water Well Disinfection Manual.* Michigan DEQ, Lansing, MI. Pp 28 to 30.

[20] Schnieders, John H. 2003. *Cleaning, Disinfection and Decontamination of Water Wells.* Johnson Screens Inc., St. Paul, MN. P52

MEASURING PH

During the mixing of the water with the chemicals the pH should be tested frequently to identify any risk of chlorine gas production, for other health and safety reasons, and to verify that the correct pH (6.0 to 7.0) of the free chlorine residual solution has been achieved. Test papers and comparison charts, calibrated field test kits or calibrated meters should be used to test the mixtures for pH.

FIGURE 8-2: MEASURING PH

Figure 8-2 shows a pH test strip being checked against a comparison chart. The test strip is placed into the solution and changes colour. The test strip's colour is matched to the colour on the comparison chart which has the corresponding pH value. In this example the test solution has a high pH.

TEMPERATURE

The effectiveness of free chlorine can change with temperature. Higher temperatures increase the amount of hypochlorous acid in the free chlorine making the treatment more effective. However, as groundwater is typically between 6 and 12°C, increasing the temperature of the well water is cost prohibitive and impractical.

SAFE HANDLING OF CHLORINE AND OTHER CHEMICALS

Proper transportation, storage and use of chemicals must be observed during all phases of well construction. In accordance with the *Ontario Health and Safety Act* and regulations made under this Act, safe practices must be followed when dealing with chlorine products and solutions, acids and other chemicals used in the "shock" chlorination process. Extra caution should be used when working with calcium hypochlorite tablets or powder and acids as they can cause chemical burns, fire, or explosion. Chlorine gas can be released if the water used to make the chlorine solution is acidified below a pH of 5 and hypochlorite is then added to the water. Therefore, proper precautions should be in place to protect workers from any possible release of chlorine gas during the treatment process.

Precautions in the "shock" chlorination process include, but are not limited to the following:

- Wear protective clothing such as gloves, aprons, goggles and a vapour mask at all times when working with chlorine products and acids
- Avoid exposure to fumes by adding well cleaning products (acids) to the water and then the hypochlorite solution only in a well ventilated area. Never mix chemicals in a confined space or a poorly ventilated area
- Avoid exposure to acid fumes and never add acid directly to a hypochlorite product
- Obtain and follow the guidelines set out in the Material Safety Data Sheet (MSDS) for any chemical product that being used. The MSDS will include the following:
    - Properties of the material
    - Hazards associated with the material
    - Personal Protective Equipment (PPE) required when using the material
    - First aid and medical attention information

"Shock" Chlorination Procedures

Calculating Chlorine Solution Dose Amounts Using Bleach

Ontario

The **Wells Regulation** requires that the water and equipment in the well must be chlorinated by dosing the well water to a concentration of at least 50 mg/L (0.008 oz/Imperial gal) and not more than 200 mg/L (0.032 oz/Imperial gal) of free chlorine.

To determine the dose that will create a free chlorine residual between 50 and 200 mg/L, a person constructing a well or installing a pump should calculate the volume of well water in the well and then the dose of the chlorine product needed.

The following calculations and tables on pages 32 to 36 are provided to assist the person in calculating the correct dose for the well.

To Calculate the Volume of Well Water in a Well

1. Measure well depth elevation and static water level elevation
2. Determine height of water column in well:

$$= \textit{well depth elevation} - \textit{static water level elevation}$$

3. If the well opening is circular, measure the inner diameter of the well.
4. Calculate the radius of the well:

$$= \frac{\textit{diameter of well}}{2}$$

5. Ensure the radius is in the same units as the length of the water column. In other words, convert centimetres to metres by dividing by 100 (or convert inches to feet by dividing by 12).
6. Calculate the area of the well casing opening:

$$= \Pi \times \textit{radius}^2$$

OR

$$= 3.14 \times \textit{radius} \times \textit{radius}$$

7. Calculate the volume of well water in the well:

$$= \textit{area of well } \text{casing } \textit{opening} \times \textit{water column in the well}$$

Use consistent units e.g. metric or imperial.

Example

The well depth is measured to be 35 metres below the ground surface and the static water level is measured to be 5 metres below the land surface.

Therefore, the water well column height is $35\ metres - 5\ metres = 30\ metres\ (100\ \ feet)$

The inner diameter of the well casing is $16\ centimetres (6\,1/4\ inches)$.

The inner radius of the well casing $= \dfrac{diameter\ of\ \ well}{2} = \dfrac{16\ cm}{2} = 8\ cm$

Remember to convert all units to metres.

Therefore, the inner radius $= \dfrac{8\ cm}{100} = 0.08\ m$

The area of the well casing opening $= \Pi \times radius^2\ = 3.14 \times 0.08\ \ m \times 0.08\ \ m\ = 0.02\ \ metres\ ^2$

The volume of the water well column $= area\ of\ \ well$ casing $opening \times water\ column\ in\ the\ well$

$= 0.02 m^2 \times 30\ m$

$= 0.6\ m^3$

$*1\ m^3 = 1{,}000 L$

$0.6 \times 1{,}000 = 600\ L$

Percent Volume of Bleach Required

Typical available chlorine concentrations of unscented bleach by weight (as noted on the product label): are as follows:

5 percent = 50,000 milligrams per litre (mg/L).

12 percent = 120,000 milligrams per litre (mg/L).

1 percent = 10,000 milligrams per litre (mg/L).

0.02 percent = 200 milligrams per litre (mg/L).

0.005 percent = 50 milligrams per litre (mg/L).

To Dose 1 Litre of Water to 50 mg/L of Free Chlorine

Using typical fresh unscented bleach (5.25 % available sodium hypochlorite) with 5 % (or 50,000 milligrams per litre) available chlorine

$$\frac{1\,L \times 50}{50{,}000} = 0.0010\ L\ of\ bleach$$

An alternative formula using percentages:

$$\frac{1\,L \times 0.005\%}{5\%} = 0.0010\ L\ of\ bleach$$

= 1 millilitre (0.035 fluid ounces) of typical bleach needed to create a concentration of 50mg/L of free chlorine in 1 litre of water

Using fresh unscented bleach (6 % available sodium hypochlorite) with 5.7 % (or 57,000 milligrams per litre) available chlorine

$$\frac{1\,L \times 50}{57{,}000} = 0.00088\ L\ of\ bleach$$

An alternative formula using percentages:

$$\frac{1\,L \times 0.005\%}{5.7\%} = 0.00088\ L\ of\ bleach$$

= 0.88 millilitres (0.031 fluid ounces) of typical bleach needed to create a concentration of 50mg/L of free chlorine in 1 litre of water

Using industrial sodium hypochlorite (12.5 % available sodium hypochlorite) with 12 % (or 120,000 milligrams per litre) available chlorine

$$\frac{1\,L \times 50}{120{,}000} = 0.00042\ L\ of\ bleach$$

An alternative formula using percentages:

$$\frac{1\,L \times 0.005\%}{12\%} = 0.00042\ L\ of\ bleach$$

= 0.42 millilitres (0.015 fluid ounces) of industrial sodium hypochlorite at 12 % available chlorine is needed to create a concentration of 50mg/L of free chlorine in 1 litre of water

There are about 227 mL in one Imperial cup. There are about 4.7 mL in one Imperial teaspoon and 28.4 mL in one Imperial fluid ounce.

To Dose 1 Litre of water to 200 mg/L of Free Chlorine

Using typical unscented bleach (5.25 % available sodium hypochlorite) with 5 % (or 50,000 milligrams per litre) available chlorine

$$\frac{1\,L \times 200}{50{,}000} = 0.0040\ L\ of\ bleach$$

An alternative formula using percentages

$$\frac{1\,L \times 0.02\%}{5\%} = 0.0040\ L\ of\ bleach$$

= 4 millilitres (0.14 fluid ounces) of typical bleach is needed to create a concentration of 50mg/L of free chlorine in 1 litre of water

Using fresh unscented bleach (6 % available sodium hypochlorite) with 5.7 % (or 57,000 milligrams per litre) available chlorine

$$\frac{1\,L \times 200}{57{,}000} = 0.0035\ L\ of\ bleach$$

An alternative formula using percentages

$$\frac{1\,L \times 0.02\%}{5.7\%} = 0.0035\ L\ of\ bleach$$

= 3.5 millilitres (0.12 fluid ounces) of typical bleach needed to create a concentration of 200mg/L of free chlorine in 1 litre of water

Using industrial sodium hypochlorite (12.5 % available sodium hypochlorite) with 12 % (or 120,000 milligrams per litre) available chlorine

$$\frac{1\,L \times 200}{120{,}000} = 0.0017\ L\ of\ bleach$$

An alternative formula using percentages

$$\frac{1\,L \times 0.02\%}{12\%} = 0.0017\ L\ of\ bleach$$

= 1.7 millilitres (0.06 fluid ounces) of industrial sodium hypochlorite at 12 % available chlorine is needed to create a concentration of 50mg/L of free chlorine in 1 litre of water

To Calculate the Dose for the Column of Well Water

Dose = Volume of Water in well x Dose for 1 litre of water

Dose is dependent on what free chlorine concentration the person is targeting, i.e. from not less than 50 to not more than 200 milligrams per litre, and also dependent on the percent of available chlorine (e.g. 5, 5.25 or 12%).

Example

Use the above calculations and the previous well example on page 28 where the 35 metre deep well has 600 Litres of water.

To obtain a concentration of 50 mg/L free chlorine using unscented bleach with 5% available chlorine multiply the 600 Litres by 1 mL = 600 mL (21 fl oz) of unscented bleach

An alternative formula using percentages

$$\frac{600\ L \times 0.005\%}{5\%} = 600\ mL\ of\ \ bleach$$

To obtain a concentration of 200 mg/L free chlorine using unscented bleach with 5% available chlorine multiply the 600 Litres by 4 mL = 2.4 L (84 fl oz) of unscented bleach

An alternative formula using percentages

$$\frac{600\ L \times 0.02\%}{5\%} = 2.4\ L\ of\ \ bleach$$

Figure 8-3: Common Measuring Cup to Assist in Calculating Amount of Bleach

Tables To Calculate Dose Using Bleach

Tables 8-1 to 8-4 provide the amount of bleach needed to dose various diameters of wells that will create 50, 100, 150 or 200 mg/L of free chlorine per metre of water column. The calculations shown on pages 27 to 31 were used to derive Tables 8-1 to 8-4.

If a different concentration of bleach is used, the calculations shown on the previous pages (27 to 31) can be used to determine the amount required to dose the well.

Notes regarding Tables 8-1 to 8-4

The volume of bleach provided by the tables will have to be multiplied by the depth of the column of well water to determine the dose for the well. The calculations consider well volumes only and do not include water in the plumbing and the water used for mixing. For additional information see the final note below.

To dose the entire well column, obtain the volume of bleach needed in millilitres from appropriate Table (Table 8-1 or Table 8-3) and multiply by the well water column height in metres.

If the height of the well water column is measured in feet, divide the height of the well water column by 5 and multiply by the volume of bleach in fluid ounces needed using Table 8-2 or Table 8-4.

The Tables provide the amounts of bleach required under the ideal conditions of neutral pH (i.e. 7 pH units), no turbidity and no total dissolved solids. Additional bleach will be required if these conditions are not met. Verify the free chlorine residual meets the **Wells Regulation** requirements of not less than 50 mg/L and no more than 200 mg/L by using test strips or other methods. Not meeting the required range can reduce the effectiveness of the treatment and will require the treatment to be repeated.

This calculation does not include the volume of any mixing water (typically 25 L or up to 4 to 5 times the volume of the well water column) or, if required, the volume of water in the plumbing (e.g. installing a pump in an existing well). It is important to consider these factors because additional bleach will be required to ensure the extra water does not dilute the target dose concentration (Table 8-7 or Table 8-8).

Table 8-1: Amount (millilitres) of Bleach Required per 1 metre of Well Water Depth to Create 50, 100, 150 and 200 mg/L of Free Chlorine where Bleach has Available Chlorine of 5% by Weight (Metric Measurements)

See Table 8-2 for the equivalent information provided in Imperial measurements.

Diameter of Well in Centimetres	Volume of Water per Metre of water depth in Litres	Volume of Bleach needed in Millilitres			
		to get 50 mg/L for each Metre of water depth	to get 100 mg/L for each Metre of water depth	to get 150 mg/L for each Metre of water depth	to get 200 mg/L for each Metre of water depth
6	3	3	5	8	10
11	9	9	18	27	37
13	14	14	28	42	56
16	20	20	40	59	79
18	27	27	53	80	106
21	34	34	69	103	138
61	292	292	583	875	1167
76	456	456	912	1367	1823
91	656	656	1313	1969	2625

Note: The formula in this table is based on the industry standard well casing diameter in inches for drilled wells and some dug wells. The formula calculates the metric equivalent for diameter, Litres per metre and then millilitres based on the initial industry standard diameter. The calculated numbers have then been rounded.

Table 8-2: Amount (fluid ounces) of Bleach Required per 5 feet of Well Water Depth to Create 50, 100, 150 and 200 mg/L of Free Chlorine where Bleach has Available Chlorine of 5% by Weight (Imperial Measurements)

See Table 8-1 for the equivalent information provided in metric measurements.

When using Feet and Imperial Fluid Ounces, a person needs to divide the entire water column height in the well in feet by 5 and then multiply the result by the corresponding concentration found in the table to obtain the required dose.

Diameter of Well in Inches	Volume of Water per 5' of water depth in Fluid Ounces	Volume of Bleach needed in Fluid Ounces			
		to get 50 mg/L for each 5' of water depth	to get 100 mg/L for each 5' of water depth	to get 150 mg/L for each 5' of water depth	to get 200 mg/L for each 5' of water depth
2 1/4	138	0.14	0.28	0.41	0.55
4 1/4	491	0.49	1.0	1.5	2.0
5 1/4	749	0.75	1.5	2.2	3.0
6 1/4	1,061	1.1	2.1	3.2	4.2
7 1/4	1,428	1.4	2.9	4.3	5.7
8 1/4	1,849	1.8	3.7	5.5	7.4
24	15,646	15.6	31.3	46.9	62.6
30	24,447	24.4	48.9	73.3	97.8
36	35,203	35.2	70.4	105.6	140.8

Note: The formula in this table is based on the industry standard well casing diameter in inches for drilled wells and some dug wells. The calculated numbers have then been rounded.

Table 8-3: Amount (millilitres) of Bleach Required per 1 metre of Well Water Depth to Create 50, 100, 150 and 200 mg/L of Free Chlorine where Bleach has Available Chlorine of 12% by Weight (Metric Measurements)

See Table 8-4 for the equivalent information provided in Imperial measurements.

Diameter of Well in Centimetres	Volume of Water per Metre of water depth in Litres	Volume of Bleach needed in Millilitres			
		to get 50 mg/L for each Metre of water depth	to get 100 mg/L for each Metre of water depth	to get 150 mg/L for each Metre of water depth	to get 200 mg/L for each Metre of water depth
6	3	1	2	3	4
11	9	4	8	11	15
13	14	6	12	17	23
16	20	8	16	25	33
18	27	11	22	33	44
21	34	14	29	43	57
61	292	122	243	365	486
76	456	190	380	570	760
91	656	273	547	820	1094
Note: The formula in this table is based on the industry standard well casing diameter in inches for drilled wells and some dug wells. The formula calculates the metric equivalent for diameter, Litres per metre and then millilitres based on the initial industry standard diameter. The calculated numbers have then been rounded.					

Table 8-4: Amount (fluid ounces) of Bleach Required per 5 feet of Well Water Depth to Create 50, 100, 150 and 200 mg/L of Free Chlorine where Bleach has Available Chlorine of 12% by Weight (Imperial Measurements)

See Table 8-3 for the equivalent information provided in metric measurements.

When using Feet and Imperial Fluid Ounces, a person needs to divide the entire water column height in the well in feet by 5 and then multiply the result by the corresponding concentration found in the table to obtain the required dose.

Diameter of Well in Inches	Volume of Water per 5' of water depth in Fluid Ounces	Volume of Bleach needed in Fluid Ounces			
		to get 50 mg/L for each 5' of water depth	to get 100 mg/L for each 5' of water depth	to get 150 mg/L for each 5' of water depth	to get 200 mg/L for each 5' of water depth
2 1/4	138	0.06	0.11	0.17	0.23
4 1/4	491	0.20	0.41	0.61	0.82
5 1/4	749	0.31	0.62	0.94	1.2
6 1/4	1,061	0.44	0.88	1.3	1.8
7 1/4	1,428	0.59	1.2	1.8	2.4
8 1/4	1,849	0.77	1.5	2.3	3.1
24	15,646	6.5	13.0	19.6	26.1
30	24,447	10.2	20.4	30.6	40.7
36	35,203	14.7	29.3	44.0	58.7

Note: The formula in this table is based on the industry standard well casing diameter in inches for drilled wells and some dug wells. The calculated numbers have then been rounded.

Calculating Chlorine Solution Dose Amounts Using Calcium Hypochlorite Powder

The following calculations are provided to be used in conjunction with Table 8-5 and Table 8-6 to assist the person in calculating the correct dose for the well.

To Dose 1 Litre of Water to 50 mg/L of Free Chlorine

1 Litre = 1 kilogram or 1,000 grams of water

To obtain the weight of a calcium hypochlorite powder at 65% available chlorine to create a dose of 50 milligrams per Litre (0.005%):

$$\frac{1Kg \times 0.005\%}{65\%} = 0.00008\ kg$$

$= 0.08\ grams\ (0.003\ ounces)$ of calcium hypochlorite is needed to create a concentration of 50mg/L of free chlorine in 1 litre of water

To Dose 1 Litre of Water to 200 mg/L of Free Chlorine

To obtain the weight of a calcium hypochlorite powder at 65 percent available chlorine to create a dose of 200 milligrams per Litre (0.02) %):

$\frac{1kg \times 0.02\%}{65\%} = 0.0003\ Kg = 0.3\ grams\ (0.01\ ounces)$ of calcium hypochlorite powder is needed to create a concentration of 200mg/L of free chlorine in 1 litre of water

To Calculate Dose for the Column of Well Water

Volume of Water in well = Weight of Water in Well x free chlorine residual desired [e.g. 50 mg/L (0.005%) or 200 mg/L (0.02 %)] divided by percent of available chlorine (65 %).

Example

Use the above calculations and the previous well example on page 28 where the 35 metre deep well has 600 Litres of water. 600 Litres of water = 600 kilograms

To obtain a concentration of 50 mg/L free chlorine using calcium hypochlorite powder with 65% available chlorine

$$\frac{600Kg \_ x \_ 0.005\%}{65\%} = 0.046 \_ kg = 46 \; grams \; (1.62 \; ounces)$$

To obtain a concentration of 200 mg/L free chlorine using calcium hypochlorite powder with 65% available chlorine

$$\frac{600Kg \times 0.02\%}{65\%} = 0.185 \; kg = 185 \; grams \; (6.52 \; ounces)$$

Tables To Calculate Dose Using Calcium Hypochlorite Powder

Table 8-5 and Table 8-6 provide the amount of calcium hypochlorite powder (at 65% available chlorine) needed to dose various diameters of wells that will create 50, 100, 150 or 200 mg/L of free chlorine per metre of water column. The calculations shown on page 36 were used to derive Tables 8-5 and 8-6.

If a different amount of calcium hypochlorite powder is used, the calculations shown on the previous pages can be used to determine the amount required to dose the well.

Notes Regarding Table 8-5 and Table 8-6

The volume of calcium hypochlorite powder provided by the table will have to be multiplied by the depth of the column of well water to determine the dose for the well. The calculations consider well volumes only and do not include water in the plumbing and the water used for mixing.

To dose the entire well column, obtain volume of calcium hypochlorite needed from Table 8-5 in grams and multiply by the well water column height in metres.

If the water well height is measured in feet, divide the height of the well water column number of feet by 5 and multiply by the volume of calcium hypochlorite in ounces needed from Table 8-6.

This calculation does not include the volume of any mixing water (typically 25 L or up to 4 to 5 times the volume of the well water column) or, if required, the volume of water in the plumbing (e.g. installing a pump in an existing well). It is important to consider these factors because additional powder will be required to ensure the extra water does not dilute the target dose concentration (see Table 8-7 or Table 8-8).

The Tables provide the amounts of calcium hypochlorite required under the ideal conditions of neutral pH (i.e. 7 pH units), no turbidity and no total dissolved solids. Additional calcium hypochlorite will be required if these conditions are not met. Verify the free chlorine residual meets the **Wells Regulation** requirements of not less than 50 mg/L and no more than 200 mg/L by using test strips or other methods. Not meeting the required range can reduce the effectiveness of the treatment and in many cases requires the treatment to be repeated.

Table 8-5: Amount (grams) of Calcium Hypochlorite Powder Required per 5 feet of Well Water Depth to Create 50, 100, 150 and 200 mg/L of Free Chlorine where Calcium Hypochlorite Powder has Available Chlorine of 65 % by Weight (Imperial Measurements)

See Table 8-6 for the equivalent information provided in Imperial measurements.

Diameter of Well in Centimetre s	Volume of Water per Metre of water depth in Litres	Dry Weight of Calcium Hypochlorite in Grams to obtain			
		50 mg/L for each Metre of water depth	100 mg/L for each Metre of water depth	150 mg/L for each Metre of water depth	200 mg/L for each Metre of water depth
6	3	0.2	0.4	0.6	0.8
11	9	0.7	1.4	2.1	2.8
13	14	1.1	2.1	3.2	4.3
16	20	1.5	3.0	4.6	6.1
18	27	2.0	4.1	6.1	8.2
21	34	2.7	5.3	8.0	10.6
61	292	22.4	44.9	67.3	89.8
76	456	35.1	70.1	105.2	140.2
91	656	50.5	101.0	151.5	202.0

Note: The formula in this table is based on the industry standard well casing diameter in inches for drilled wells and some dug wells. The formula calculates the metric equivalent for diameter, Litres per metre and then millilitres based on the initial industry standard diameter. The calculated numbers have then been rounded.

Table 8-6: Amount (ounces) of Calcium Hypochlorite Powder Required per 5 feet of well water depth to create 50, 100, 150 and 200 mg/L of Free Chlorine where Calcium Hypochlorite Powder has Available Chlorine of 65 % by Weight. (Imperial Measurements)

See Table 8-5 for the equivalent information provided in metric measurements.

When using Feet and Imperial Fluid Ounces, a person needs to divide the entire water column height in the well in feet by 5' and then multiply the result by the corresponding concentration found in the table to obtain the required dose.

Diameter of Well in Inches	Volume of Water per 5' of water depth in Fluid Ounces	Dry Weight of Calcium Hypochlorite in Ounces to obtain			
		50 mg/L for each 5' of water depth	100 mg/L for each 5' of water depth	150 mg/L for each 5' of water depth	200 mg/L for each 5' of water depth
2 1/4	138	0.01	0.02	0.03	0.04
4 1/4	491	0.04	0.08	0.11	0.15
5 1/4	749	0.06	0.12	0.17	0.23
6 1/4	1,061	0.08	0.16	0.25	0.33
7 1/4	1,428	0.11	0.22	0.33	0.44
8 1/4	1,849	0.14	0.29	0.43	0.57
24	15,646	1.2	2.4	3.6	4.8
30	24,447	1.9	3.8	5.7	7.5
36	35,203	2.7	5.4	8.1	10.9

Note: The formula in this table is based on the industry standard well casing diameter in inches for drilled wells and some dug wells. The calculated numbers have then been rounded.

Preparing Mixing Dose above Ground Surface

Adding bleach or calcium hypochlorite directly to the well typically does not allow for a uniform dose of the well water column and makes it almost impossible to control the pH. To properly mix and if necessary control the pH, it is important to create the mixing dose in a bulk mixing or other container set on the ground surface. Therefore, extra water used to create the mixing dose has to be added to the water well column volume to provide the total water needed to be dosed.

If 25 Litres of water is used to mix the solution above the ground surface, then Table 8-7 or Table 8-8 provide the amount of unscented bleach and weight of calcium hypochlorite powder required to dose the 25 Litres (or 5 gallons) of extra water used to mix the chlorine solution at 50, 100, 150 and 200 milligrams per Litre.

Table 8-7: Amount of Bleach or Calcium Hypochlorite Powder Required to Dose 25 Litres of water. (Metric Measurements)

See Table 8-8 for the equivalent information provided in Imperial measurements.

Bleach or Calcium Hypochlorite Powder Available Chlorine	Volume of Bleach (Millilitres) or Weight of Calcium Hypochlorite Powder (Grams) needed to dose 25 Litres			
	50 mg/L for 25 Litres of mixing water	100 mg/L for 25 Litres of mixing water	150 mg/L for 25 Litres of mixing water	200 mg/L for 25 Litres of mixing water
Bleach with 5% Available Chlorine	25	50	75	100
Bleach with 12% Available Chlorine	10	21	31	42
Hypochlorite Powder with 65% Available	2	4	6	8

Table 8-8: Amount of Bleach or Calcium Hypochlorite Required to Dose 5 Gallons of water. (Imperial Measurements)

See Table 8-7 for the equivalent information provided in metric measurements.

Bleach or Calcium Hypochlorite Powder Available Chlorine	Volume of Bleach (fluid ounces) or Calcium Hypochlirite Powder (ounces) needed to dose 5 Gallons			
	50 mg/L for 5 Gallons of mixing water	100 mg/L for 5 Gallons of mixing water	150 mg/L for 5 Gallons of mixing water	200 mg/L for 5 Gallons of mixing water
Bleach with 5% Available Chlorine	0.8	1.6	2.4	3.2
Bleach with 12% Available Chlorine	0.3	0.7	1	1.3
Hypochlorite Powder with 65% Available	0.06	0.12	0.18	0.25

Best Management Practice – Mix 4 to 5 times the Well Volume of Solution Above Ground Surface Prior to Dosing the Well

Where practical, a dosing solution of 4 to 5 times the water column should be mixed in a bulk mixing container set on the ground surface and poured into the well to account for the:

- Standing well volume,
- Saturation of the adjacent formation and if present,
- Saturation of the gravel pack.

FORMULA FOR pH CONTROL DURING CHLORINATION

Mixing hypochlorite solutions will raise the pH and decrease the amount of effective hypochlorous acid available for disinfection. To control the pH, acids such as white vinegar can be added to the mixing water prior to adding the bleach. If the alkalinity of the water is measured or known then the following formula can be used:

$$Litres\ of\ White\,Vinegar = \frac{Mixing\,Water\ Alkalinity}{100} \times \frac{Chlorine\ Dose}{500} \times \frac{Mixing\,Water\,Volume\,(Litres)}{100}$$

OR

$$Gallons\ of\ White\,Vinegar = \frac{Mixing\,Water\ Alkalinity}{100} \times \frac{Chlorine\ Dose}{500} \times \frac{Mixing\,Water\,Volume\,(Gallons)}{100}$$

Alkalinity and chlorine dose are in mg/L and volume is in Litres and Imperial Gallons

To Calculate the Volume of Water for Typical Horizontal Pipes (Waterline) From Well to Building

Even though it is not a requirement of the **Wells regulation**, the plumbing in the building should be chlorinated along with the well to reduce pathogens in the entire water distribution system. The calculation used to determine the volume of the water well column can be used to determine the water in the different diameter plumbing lines within the building.

For a Typical Pipe Inside Diameter – 2.5 cm (1")

Radius: 1.3 cm = 0.013 metres
Area: 3.14 x 0.013 m x 0.013 m = 0.0005 m^2
Volume per 1 metre of pipe $= 1\,m \times 0.0005 m^2$

$$= 0.0005\,m^3 = 0.5\,Litres\,(0.1\,imperial\ gallons)$$

Therefore multiply length in metres of 3.2 cm (1 ¼ ") horizontal pipe from plumbing to well by 0.5 Litres to obtain total volume of water in pipe.

For a Typical Pipe Inside Diameter - 3.2 cm (1 ¼")

Radius: 1.6 cm = 0.016 metres
Area: 3.14 x 0.016 m x 0.016 m = 0.0008 m^2
Volume per 1 metre of pipe: $= 1\,m \times 0.0008 m^2$

$$= 0.0008\ m^3 = 0.8\ Litres\ (0.2\ imperial\ \ gallons)$$

Therefore multiply length in metres of 3.2 cm (1 ¼") horizontal pipe from plumbing to well by 0.8 Litres to obtain total volume of water in pipe.

In calculating the amount of water in the plumbing it is also important to add the volume of the hot water tank (typically noted on the tank's information) and any water storage tank. The additional water in the plumbing has to be added to the volume of the mixing water and the water well column.

Procedure for "Shock" Chlorination on Same Day after Completing the New Well's Structural Stage

On the day that the person constructing the well finishes the well's structural stage, the person must ensure the well is disinfected.

To "shock" chlorinate a new well after debris removal and flushing have taken place (see Process of Disinfection on page 10 of this chapter), the person constructing the well must dose the well to obtain a free chlorine concentration of not less than 50 mg/L and not more than 200 mg/L.

The following steps show one suggested method of dosing the well with best practices that achieve the **Wells Regulation** disinfection requirements. There may be other methods, that meet the Wells Regulation requirements, and that can be used to "shock" chlorinate a well.

One Method of Dosing the Well Water Which Meets the Wells Regulation Requirements

Step 1: Calculate the volume of the well water in the well column (see page 27).

Also, add the mixing water to the calculated volume of water (e.g. an additional 25 Litres of water). This mixing water will be placed in a container set on the ground surface and used to prepare the chlorine solution.

For example, the well has 375 Litres of water in the well column and the person will use 25 Litres of water to mix. The actual volume of water that needs to be dosed to not less than 50 mg/L and not more than 200 mg/L free chlorine is 375 + 25 = 400 Litres. These additional 25 Litres of clean water is the typical volume of water used in the mixing of the chlorine solution at the site. In other cases where the well and the aquifer space around the well need to be treated, the additional water may be five times the volume of the water well column.

Step 2: Determine the free chlorine concentration (e.g. 50, 100, 150 or 200 mg/L) within the required range needed to achieve the most effective treatment. It is also necessary to determine the type of hypochlorite product (e.g. bleach or calcium hypochlorite powder) that will be used in the treatment process. For better mixing results use fresh, unscented bleach.

Step 3: Calculate the amount of chlorine solution required to achieve the most effective treatment determined in step 2 (above). To assist in the determination of the dose needed to achieve 50, 100, 150 or 200 mg/L free chlorine in the well use Table 8-1 to Table 8-6. To determine an alternate concentration of free chlorine within the required range of 50 to 200 mg/L see the formulas on pages 29, 28, 31 and 36.

Step 4: For mixing a single well volume insitu, mix 25 litres of clean potable water and the calculated amount of chlorine product in a clean container (pail).

See "Best Management Practice – Mix Clean and Potable Water, Vinegar and Chlorine Products prior to Dosing the Well" (below).

Best Management Practice – Mix Large Volume of Clean and Potable Water, Vinegar and Chlorine Products prior to Dosing the Well to achieve higher concentrations of Hypochlorous Acid.

Put a volume of 4 to 5 times the volume of the well water column of clean and, potable water into a bulk mixing container set on the ground surface. To create the more effective hypochlorous acid, lower the pH of the mixing water to 4.5 to 5 with NSF International approved acids before adding the chlorine product as described in the section titled *pH Levels* (page 25). The easiest and most effective acid is distilled white vinegar. A formula to achieve the most effective treatment using vinegar is shown on page 44.

Step 5: Prepare the chlorine solution by adding the calculated amount of liquid bleach or calcium hypochlorite powder to the mixing water into the container, taking into account pH levels and other factors that will impact the effectiveness of the dose.

Step 6: Pour this solution into the well and adequately mix to distribute the dose throughout the well column and let it stay undisturbed in the well for the required minimum of twelve (12) hours. Pouring options to ensure mixture throughout the entire well column include:

- If the chlorine dose is poured in, run a clean and spray-chlorinated drill string with a surge block or another development tool up and down in the well column. Surge blocks are very effective in wells with screens.
- Pump the chlorine dose in the well, using the injection pump of the rig. Surge with air to lift the column of water and drop back down to mix without discharging the water out of the well.
- Pour the chlorine dose in a dug or bored well while pumping and re-circulating well water with a pump, other than the water supply pump (i.e. discharge pumped water back into the well).
- Place the chlorine dose in the bailer and raise and lower the bailer to agitate the well water.
- Install a clean and spray-chlorinated tremie pipe near the bottom of the well. Inject the dose into the well through the tremie pipe and allow the dose to discharge into the well. Raise the tremie pipe during the injection process. This method can be used for both drilled and driven point wells.
- Install a jetting tool into the well and jet the solution throughout the well water column.

By using the Best Management Practice found in Step 4, a person can inject the dose solution into the well, formation around the well and if necessary a gravel pack. The pouring should be done at a rate to prevent any overflow of the solution out of the top of the well.

It is important to conduct a free chlorine residual test shortly after dosing the well to ensure the free chlorine residual is within the required range and will likely be in the same range during the required testing period of at least 12 hours to not more than 24 hours after dosing the well. If the testing shortly after dosing shows a problem (<50 or >200 mg/L free chlorine) the person constructing the well can immediately:

- Discharge or dispose of the chlorinated water in an approved manner (See "Best Management Practice – Handling Heavily Chlorinated Water Discharge", page 54) and re-dose the well with another chlorine solution or
- Adjust the concentration of the free chlorine accordingly by either adding water or adding additional chlorine solution.

Best Management Practice – Ensuring Free Chlorine Residual Remains Above 50 mg/L for Entire Period

An initial dose that creates a concentration significantly higher than 50 mg/L of free chlorine should be used to ensure the free chlorine remains above 50 mg/L for the entire treatment period.

Best Management Practice – Using Alternate Disinfection Method in Areas of High Arsenic Concentrations

If the well is located in an area of high naturally occurring arsenic, high concentrations of free chlorine could release arsenic into the well water after the treatment process. It is important not to exceed a dose of 100 mg/L free chlorine in this type of environment and obtain a Director's written approval to use an alternate disinfection method (see page 65.)

Best Mangement Practice – Using Field Kit Equipment to Test Water for Chemical Parameters

Field kit equipment should be used to test the water for total dissolved solids (TDS), turbidity and the other common parameters to determine if additional cleaning of the well or additional chlorine solution is needed.

Step 7: The treatment process has been completed and no further work is required as long as the person constructing the well ensures that the water will not be used for human consumption. If the person cannot ensure that the water will not be used for human consumption then the person who undertakes the construction of the well must continue with the next steps.

In highly fractured bedrock environments or highly permeable overburden environments where heavily chlorinated water can migrate from the well off-site to receptors (e.g. wells, rivers, streams) the person constructing the well should carefully calculate the volume and concentration of the chlorinated water to reduce the risk of off-site impacts. It is important to take all reasonable care to prevent the movement of chlorinated water off-site. It may be advisable to monitor off-site wells and have a contingency plan in case chlorinated water impairs off-site wells or other receptors.

If the Person Constructing the Well cannot ensure that the Water Will Not be Used for Human Consumption:

Step 8: At least 12 hours and not more than 24 hours after dosing the well, the person undertaking the construction must obtain a grab sample of the well water using clean sampling equipment and bottles. The grab sample must be tested for free chlorine residual. Testing can be done using simple test strips (Figure 8-4) similar to pH test strips shown in (Figure 8-2). If the free chlorine residual is within the required range (50-200 mg/L) see Step 11 on page 46, otherwise see Step 9.

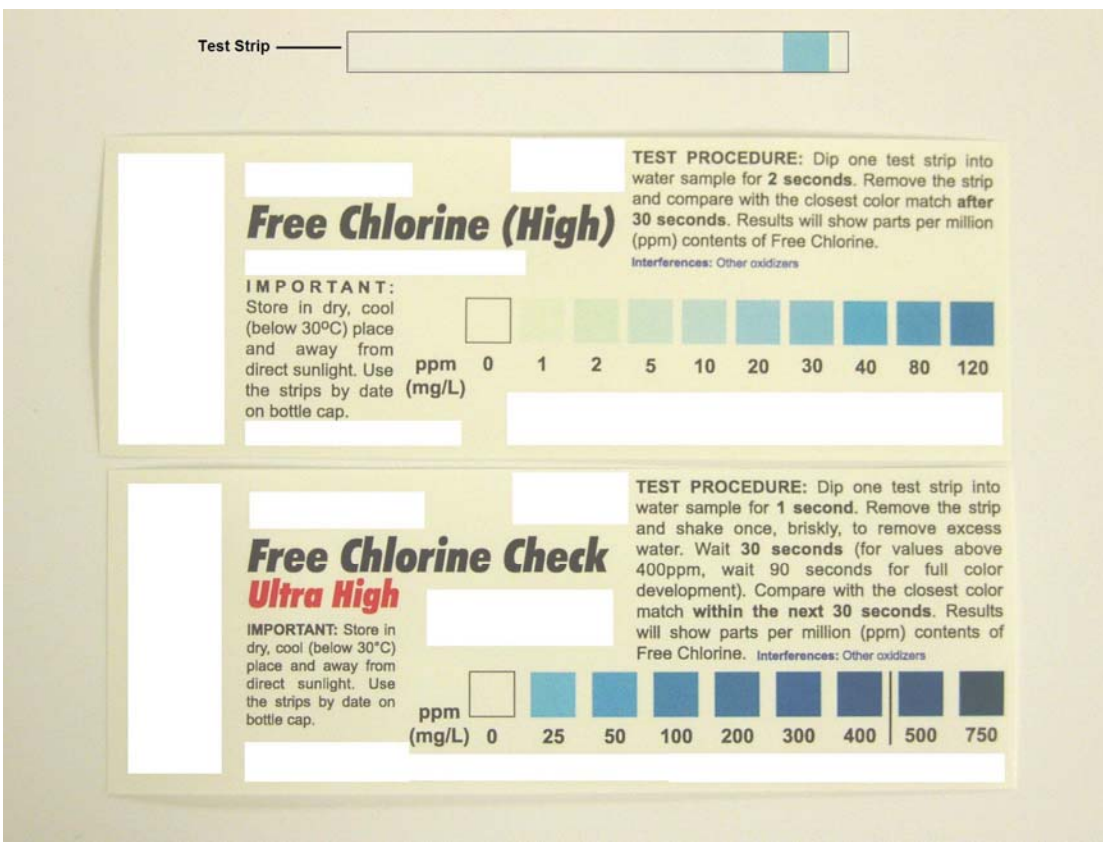


FIGURE 8-4: MEASURING FREE CHLORINE

Figure 8-4 provides an example of a free chlorine residual test strip (at the top of diagram) and a comparison chart for various free chlorine residual concentrations. The test strip is placed into the chlorinated water solution and changes colour. The test strip's colour is matched to

the comparison chart which has the corresponding free chlorine residual concentration. A test strip for the 0 to 120 mg/L range shown at the top of Figure 8-4 was placed in the chlorinated water. The blue colour on the test strip matches a free chlorine residual of 30 mg/L on the 0 to 120 mg/L free chlorine residual comparison chart (shown in the middle of Figure 8-4). Therefore, further work needs to be done to bring the free chlorine in the water above 50 mg/L but not more than 200mg/L. A 0 to 750 mg/L free chlorine residual comparison chart is also shown in the bottom of Figure 3. The 0 to 750 mg/L free chlorine residual comparison chart also has similar test strips for testing free chlorine residual in water.

Step 9: If the test shows a free chlorine residual below 50 mg/L or more than 200 mg/L, then the person who undertakes the construction must pump the well water out of the well until the well water has a free chlorine residual concentration of less than 1 mg/L. The person undertaking the construction of the well can obtain a sample of the water in a clean sample container and use the test strips and comparison chart shown in Step 8 to determine the free chlorine concentration.

See Best Management Practice – Handling Heavily Chlorinated Water Discharge, page 54 for details on how to properly discharge or dispose of heavily chlorinated water.

Step 10: If step 9 applies (i.e. the free chlorine residual is outside of the required range) repeat steps 1 to 8 until the test shows the required free chlorine residual concentration range is between 50 to 200 mg/L after 12 hours and not more than 24 hours after the water is re-dosed.

Step 11: After a test in accordance with step 8 shows the free chlorine residual is within the required range (50-200 mg/L), the person constructing the well must pump the well water out of the well until the well water has a free chlorine residual concentration of less than 1 mg/L. The person constructing the well can obtain a sample of the water in a clean sample container and use the test strips and comparison chart shown in Figure 8-4 to determine the free chlorine residual.

See Best Management Practice – Handling Heavily Chlorinated Water Discharge, page 54 for details on how to properly discharge or dispose of heavily chlorinated water.

Step 12: Before the well is used as a source of water for human consumption, the person undertaking construction of the well must ensure that the well purchaser is provided with a written record of the test results. An example of what a written record could look like is shown in Figure 8-5.

Step 13: Indicate on the well record that the well has been disinfected.

FIGURE 8-5: AN EXAMPLE OF A WRITTEN RECORD FOR REPORTING FREE CHLORINE RESIDUAL TESTS

1: Is this a: New Well | Alteration to Existing well | Pump Installation (Circle)

2: Well tag number: | ____________________

3: Well purchaser name: | ____________________________________

4: Well purchaser address: | ____

5: Well purchaser telephone number: | ______________

6: Location of well: | ____

7: Date of structural stage of well completed/pump installed: | / / 2 (DD/MM/YYYY)

8: Initial date and time of dosing well: | / / 2 (DD/MM/YYYY) | Time: AM or PM (circle)

9: Date and time for testing:

Free chlorine residual: | / / 2 (DD/MM/YYYY) | Time: AM or PM (circle)

10: Concentration of free chlorine residual and time elapse after dosing

Between 12 to 24 hours after dosing the well: | mg/L | _____ Hours

11: Did test have to be repeated? Yes or No (Circle)

If yes continue with next questions | If no go to Lines 21 and 22.

12: Date of pumping out chlorinated well-water: | / / 2 (DD/MM/YYYY)

13: Concentration of free chlorine residual after pumping well-water out of well: | mg/L

14: Date and time of re-dosing well: | / / 2 (DD/MM/YYYY) | Time: AM or PM (circle)

15: Concentration of free chlorine residual and time elapse after dosing

Between 12 to 24 Hours After Re-dosing the Well: | mg/L | _____ Hours

16: Did test have to be repeated again? Yes or No (Circle)

If yes continue with next questions | If no go to Lines 21 and 22.__

17: Date of pumping out chlorinated well- water: | / / 2 (DD/MM/YYYY)

18: Concentration of free chlorine residual after pumping well-water out of well: | mg/L

19: Date and time of re-dosing well: | / / 2 (DD/MM/YYYY) | Time: AM or PM (circle)

20: Concentration of free chlorine residual and time elapse after dosing

between 12 to 24 hours after re-dosing the well: | mg/L | _____ Hours

21: Concentration of free chlorine residual after pumping well-water out of well: | mg/L

22: Type of test used to measure free chlorine residual concentration: (circle)

Test strips Colourimeter Other (specify) ______________________________

Name of person constructing the well/ installing a pump ____

(please print first and last name)

Well technician licence number ________________________

Well contractor licence number ________________________

____ ____________

Signature of person constructing the well/ installing a pump Date

PROCEDURE FOR "SHOCK" CHLORINATION AFTER INSTALLING THE PUMP OR AFTER ALTERING AN EXISTING WELL

As soon as possible after the pumping equipment has been installed in a well or where a well has been altered (other than a minor alteration), the person doing the work must ensure that the well water is dosed to obtain a free chlorine concentration of not less than 50 mg/L and not more than 200 mg/L.

This occurs after the debris removal and flushing have taken place (see Process of Disinfection, page 12).

The following steps show one suggested method of dosing the well with best practices that achieve the **Wells Regulation** disinfection requirements. There may be other methods, that meet the **Wells Regulation** requirements, and that can be used to "shock" chlorinate a well after pump installation or after an alteration.

ONE METHOD OF DOSING THE WELL WATER WHICH MEETS THE WELLS REGULATION REQUIREMENTS

Step 1: Store enough clean water to meet household and farm water needs for a minimum of 12 hours.

Step 2: Before treating the water system, remove or bypass any carbon filters, water softeners and other treatment units on the plumbing. Highly chlorinated water can damage treatment units including copper piping and fixtures. Follow the manufacturer's recommendations to ensure treatment systems are properly disinfected. Be sure that the hot water tank's heat source is shut off.

Step 3: Follow Steps 1 to 8 from the "Procedure for "Shock" Chlorination on Same Day after Completing the New Well's Structural Stage", page 46 **except** for the following:

- During Step 1 (page 46) where the building's plumbing is to be chlorinated along with the water in the well, the person should:
  - estimate the volume of the water in the residential plumbing including the hot water and pressure tanks (see page 31), the extra water for mixing (e.g. 25 L) and the volume of the well water column (see page 20).
  - drain all water out of plumbing including the hot water tank prior to dosing.
- For Step 5 (page 47) and where the building's plumbing and water in the well are to be chlorinated, the person altering the well or installing the pump can install a clean hose from an outdoor tap into the top of the well. The person can then dose the well and circulate the chlorinated water using the building's own plumbing to evenly distribute the treated water. In other cases where the well and the aquifer near the well need to be chlorinated, the other methods shown in Step 6 may be needed to distribute the chlorine dose.
- During Step 6, open all faucets (hot, cold, laundry and outside) in the plumbing and let the water run until the chlorine odour is detected. Since chlorinated water can damage the action in a septic system, chlorinated water should not be allowed into the building's sewage system.
- Unlike new well construction, the person altering an existing well or installing the pump is not allowed to stop at Step 7 (page 49) even if the well will not be used for human consumption and must continue with the next steps.

Step 4: Follow Steps 9 to 13 from the "Procedure for "Shock" Chlorination on Same Day after Completing the New Well's Structural Stage", page 46.

- For steps that involve the discharge of chlorinated water, before turning on the pump after the 12-24 hour period, faucets or fixtures discharging to the septic tank systems should be temporarily diverted to an outside discharge point to avoid affecting the septic system.

See "Best Management Practice – Handling Heavily Chlorinated Water Discharge," page 54 for details on how to properly discharge or and dispose of heavily chlorinated water.

Restrict Water Use During "Shock" Chlorination Period

During the "shock" chlorination period, it is important that the person constructing the well communicate with the well owner/well purchaser and take necessary precautions to ensure that the chlorinated water is not used or consumed.

Inform the well owner and well purchaser of the following[21]:

- **Do not drink the water** and avoid all body contact with the water.
- Minimize water use to ensure that chlorinated water remains in the well in the required amounts.
- Ventilate if strong chlorine odours are detected.
- Do not use chlorinated water for laundry, plants, fish tanks, etc.

Best Management Practice – Turn Off Pump During Disinfection Period

The pump should be shut off for the entire period of treatment to ensure the water is not mistakenly used by the well owner/well purchaser. Also ensure the water system has been set to bypass all water treatment units.

[21] Holben, Ronald J., and Gaber, Michael R.S. 2003. *Michigan Department of Environmental Quality: Water Well Disinfection Manual.* Michigan DEQ, Lansing, MI. P. 38.

Handling Heavily Chlorinated Water Discharge

Best Management Practice – Handling Heavily Chlorinated Water Discharge

All reasonable care should be taken to ensure that chlorinated well water is not pumped out in a quantity, concentration, or under conditions that may impair the quality of surface water or groundwater, or that cause, or are likely to cause, adverse effects to the natural environment.

To handle water discharge, use a hose to pump the water into a safe area in a yard or to another safe location on the property where the chlorinated water will not cause damage.

When pumping discharge water, *avoid* the following[22]:

- Pumping strong chlorine solutions onto land or landscape plants
- Running the water into the household sewage lines and therefore septic system as this may overload the leaching bed or cause the system to malfunction by killing the active bacteria in the tank
- Running water into a lake, stream or other body of water that could impair the waters, and
- Flushing for long periods where the water will flow onto a neighbouring property or roadways that could cause damage to property and/or flooding

Highly chlorinated water can also be neutralized using chemicals such as sulfur dioxide, sodium bisulfite, sodium metabisulfite or sodium sulfite[23]. When using a neutralizer, it is important to pump the chlorinated water from the well into a large storage tank on the ground surface. The neutralizer is then mixed with the chlorinated water in storage tank. Free Chlorine test strips (Figure 8-4) should be used to verify the chlorinated water has been neutralized.

No waste management or sewage approvals are required for discharging chlorinated water onto the owner's property. However, as indicated above, no person shall discharge the heavily chlorinated water that causes or may cause an adverse effect to the natural environment.

[22] Holben, Ronald J., and Gaber, Michael R.S. 2003. *Michigan Department of Environmental Quality: Water Well Disinfection Manual*. Michigan DEQ, Lansing, MI. Pp 18, 33.

[23] American Water Works Association (AWWA). 2003. ANSI/AWWA C 654 - 03 – "*"Disinfection of Wells."*." AWWA, Denver, CO. 2003. www.awwa.org Section 4.6, p. 6 and Appendix B, P 11.

Continued from Best Management Practice on Previous Page

A sewage works Certificate of Approval under the *Ontario Water Resources Act* will be required if the person discharges heavily chlorinated water off the well owner's property and the discharge capacity exceeds 10,000 litres per day. A guide to explain the sewage works process can be found at the following website http://www.ene.gov.on.ca/envision/gp/4063e.htm.

If a safe discharge location is not available, the person constructing the well may need to properly store and transport the chlorinated water.

If a person wishes to haul heavily chlorinated water to a regulated waste disposal site, the person must have an approved waste management system (i.e. holds a valid Certificate of Approval) to carry the chlorinated water, must meet the requirements of the General – Waste Management regulation (Regulation 347 as amended made under the *Environmental Protection Act*) and must dispose of the heavily chlorinated water at a licensed facility that is listed on the Certificate of Approval. A guide to explain approved waste management systems can be found at the following website:
http://www.ene.gov.on.ca/envision/gp/4185e.pdf

Exemption From Disinfecting Flowing Wells

The disinfection requirements do not apply to minor alterations, test holes, dewatering wells and flowing wells.

Best Management Practice – Disinfecting Flowing Wells

In some situations it may be advisable to disinfect flowing wells. One of the following methods may be used:

- Extending casing above the static water level and following the disinfection procedure in this chapter to the extent possible
- Sealing the top of the well with a packer and inserting a tube. The chlorine solution is injected through the tube. The dosing, contact time and discharge of the heavily chlorinated water should follow this chapter to the extent possible.
- Inserting a perforated container that has solid calcium hypochlorite tablets and allowing the tablets to dissolve near the bottom of a flowing well. The natural upflow will allow for the chlorinated water to disperse throughout the entire well water column. To reduce the loss of free chlorine during the process, the flow of water from the well should be restricted if possible.

Factors to consider when chlorinating flowing wells include:

- The potential for blow out due to improper construction
- The potential for impairing water with discharging chlorinated water from the flowing well (see Handling Heavily Chlorinated Water Discharge Best Management Practice on previous page) and
- The health and safety of on-site workers.

Exemption to Allow Well Purchaser To Discharge Chlorinated Water

Ontario

The chlorination process after the initial dosing does not apply to an alteration of a well if all of the following conditions are met:

- The alteration involves the urgent replacement or repair of a pump that unexpectedly failed,
- No water supply is immediately available as an alternative to the water from the well, and
- The well purchaser provides written instructions to the person altering the well (repair or replacement of pump) to discontinue the disinfection process after the person altering the well initially doses the well to a concentration not less than 50 mg/L and not more than 200 mg/L of free chlorine

In this case, the following is required:

- The well purchaser must ensure that, before the well water is used for any purpose, water is pumped from the well until no odour of chlorine remains in the well water, and
- The person who undertakes the alteration must retain the written instructions from the well purchaser to discontinue disinfection, for two years.

Best Management Practice - Using Test Strips or other Free Chlorine Residual Testing Equipment

To verify the chlorinated water has been removed from the well, inexpensive test strips as shown in Figure 8-4 or other types of free chlorine residual testing equipment should be used.

Replacing Pumping Equipment Above or Adjacent to a Well

Ontario

Disinfection of the well is required during the replacement of a pump that is installed above or adjacent to a well or in a well pit if the well cap or well cover is removed during the installation.

Best Management Practice – Disinfecting all Equipment

To reduce the risk of contamination, the inside and outside of all new or used pumping equipment in or connected to a well should be disinfected.

Collection and Analysis of Water Samples for Indicator Bacterial Parameters

Proper collection and analysis of well water samples after a “shock” chlorination treatment are a good way to determine if the well water is safe for human consumption and bathing.

When well water is tested for bacterial (as opposed to chemical) parameters, typically laboratories test for certain bacteria called indicator organisms or indicator bacteria. The presence of these indicators acts as an early warning signal. They indicate that the well water may not be safe for human consumption. The indicator bacteria usually show up in a test result if water has become contaminated by surface water runoff, soil bacteria, animal waste, sewage waste or some agricultural activities.

Best Management Practice – Sampling and Analyzing Well Water

Development, cleaning, flushing, “shock” chlorination treatment and removal of heavily chlorinated water are designed to eliminate pathogens from the well water.

“Shock” chlorination treatment does not necessarily guarantee the water is bacteriologically safe for human consumption or bathing. For example, a source of contamination may be impairing the quality of the groundwater that the well has penetrated. Also, various chemical reactions between the chlorine solution and materials in the water (e.g. biofilm) may prevent the elimination of all pathogens in the water.

Therefore the final step of well disinfection is to verify there are no indicator bacteria in the well water.

The person constructing the well or the well owner should sample the well water for bacterial indicator parameters. The first sample should occur 24 to 48 hours after the heavily chlorinated water has been pumped from the well, pumping equipment and plumbing. Two more samples should be taken one to three weeks apart.

All samples should be submitted to a public health laboratory or an accredited and licensed private laboratory. The laboratory should analyze the samples for bacterial indicator parameters to verify that the treatment has eliminated indicator bacteria from the well water.

If the test results indicate that the well is not contaminated with indicator bacteria, it may still contain other contaminants such as chemicals. Tests for chemical, radiological or other bacterial parameters will verify that the well water is safe for human consumption and bathing.

Indicator Bacteria

There are two indicator organisms that Ontario public health laboratories will test for in a well water sample. These are Total coliform and Escherichia coli (*E. coli*). The Ministry of Health and Long Term Care has produced a Fact Sheet titled *Water Safety: Pathogens and Your Well Water*. The fact sheet is available at the following website: (http://www.health.gov.on.ca/english/public/pub/watersafe/watersafe_pathogens.html#1). The fact sheet provides the following information on total coliform and *E. coli* bacteria.

Total Coliform

- A general family of bacteria that is commonly found in animal and human wastes, surface soils and vegetation.
- May indicate contamination of water with disease-causing organisms, and possible evidence of surface water runoff contamination in well water.
- Provides an early warning signal that there may be a problem with the water supply.

E. coli

- Are a group of bacteria that commonly live in the intestines of warm-blooded animals.
- Indicate recent fecal contamination from sources such as human sewage or livestock waste.
- Indicate that there is a problem with the water supply.

Do not use water containing total coliform or any *E. coli* for drinking, making infant formula and juices, cooking, making ice, washing fruits or vegetables, brushing teeth, hand washing, bathing or showering unless it has been properly disinfected or treated.

Sampling and Analyzing Well Water

The Ministry of Health and Long Term Care has produced a Fact Sheet titled *Water Safety: Putting Your Well Water to the Test*. The fact sheet is available at the following website: http://www.health.gov.on.ca/english/public/pub/watersafe/watersafe_welltest.html

The fact sheet provides the details in Table 8-9 regarding the roles of various groups involved in bacterial sampling and testing. The table in the fact sheet has been modified to represent the requirements in the current **Wells Regulation**.

Table 8-9: Groups Involved in Bacteriological Sampling and Testing

Service	Contact If...	How to Locate
Public Health Unit	• Surface water, or human or animal waste is suspected to have entered a well. • A water sample bottle for indicator bacteria testing is needed. • Help in interpreting water quality sample results is needed.	• Local public health unit should be listed in the blue pages of the telephone book • Information is available at the following website: http://www.health.gov.on.ca/english/public/contact/phu/phuloc_mn.html • Toll free INFOline at: 1-866-532-3161 In Toronto: 416-314-5518 TTY: 1-800-387-5559
Public Health Lab	• A water sample bottle for indicator bacteria testing is needed. • Public Health Labs perform bacterial water testing free of charge	• Toll free INFOline at 1-866-532-3161 In Toronto: 416-314-5518 TTY 1-800-387-5559
Private Accredited Lab	• There are concerns about chemicals in a well • Private labs test for bacterial and	• For information about accredited laboratories, contact the Ministry of the Environment at 1-800-565-4923
Licensed Well Contractor	• There are concerns that require a well to be upgraded • Can assist in sampling the well and submitting the sample to the laboratory	• Listings in the Yellow Pages (e.g. under the ***Water Well Drilling & Services*** heading) • A list of well contractors can be found at: http://www.waterwellontario.ca/ • It is important to ensure that the well contractor is properly licensed to provide this service
Professional Geoscientists and Engineers Certified Engineering Technicians and Technologists	• Assistance with identifying sources of contamination and pathways is needed. • Can assist in sampling the well and submitting the sample to an accredited laboratory • Assessment and recommendations	• Listings in the local Yellow Pages (e.g. under the ***Environmental Consultants*** heading) • Other listings may be available at: • http://www.peo.on.ca, http://www.apgo.net or http://www.oacett.org

Ministry of the Environment (local area or district office)	• Surface water, or human or animal waste is suspected to have entered a well • Help is needed in interpreting water quality sample results or the **Wells Regulation**	• http://www.ene.gov.on.ca • http://www.ontario.ca/ONT/portal51/drinkingwater

How to Collect Well water Samples

1. Obtain a clean and sterile sample bottle from the local public health unit, public laboratory or private laboratory along with the required paperwork.
2. Determine the location for taking the sample.
   - If it is a new well, a temporary clean pump and waterline may have to be installed into the well. As an alternative, a grab sample using clean sampling equipment will have to be lowered into the well.
   - If it is an existing well attached to established plumbing, in addition to the above, a person may be able to sample the water from a sampling tap at the pressure tank, kitchen or bathroom sink or at an outside faucet. These locations need to be accessible for sampling, clean, in frequent use, flow in a uniform stream and only hooked into cold, raw water (i.e. should not be taken from a combination hot/cold tap). Avoid taking samples where the tap leaks or is subject to splashing.
   - In some situations, the outside tap is a good location to take the sample, provided it is commonly used, clean and it is not hooked up to a hose at the time of sampling.
   - Aerators may impact the sample result. The test for indicator bacteria is to verify if the treatment on the well water worked. It is important that the aerator be removed from the tap if present.
3. If a tap is chosen, clean and disinfect the sampling location with alcohol wipes or a clean cloth soaked in a chlorine solution. Ensure the chlorine solution or alcohol is removed (e.g. air dries) from the tap before sampling.
4. If a pump is used in a new well or a tap is used in an existing well with established plumbing, flush the system at as high a rate as possible for at least 5 minutes at the sample location point to obtain fresh groundwater from the aquifer. The longer the flushing, the more likely the sample will represent the true groundwater quality because the water that has been stagnant in the plumbing and well column will have been flushed out.
5. Reduce the flow after at least 5 minutes of flushing.

   In some cases, problems such as biofilm in the well are protecting bacteria that may be living in the well. If casing and borehole water is removed from the well so that fresh groundwater from the aquifer is being delivered to the sample point, a person will miss any free swimming resident organisms. Sampling for coliform like organisms living in or on the side of the well with biofilm should be done only after the well has set idle for 8 to 12 hours. After this period, a volume of water equal to the volume in the plumbing within the building, the horizontal waterline to the well and the drop pipe in the well (pump out first) should be flushed to allow for the true casing and borehole water to be sampled.

6. Using protective and clean vinyl, latex or nitrole gloves, remove cap from sterile sample bottle and if possible do not set the cap on any surface.
7. Put the sample bottle under the flow of water and fill the water to no higher than the top of the sample bottle's label.

Do not let the water overflow or pour any water out of the sample bottle as the laboratory has put a chemical (sodium thiosulfate preservative) into the bottle to inactivate chlorine and preserve the sample.

8. Remove the sample bottle from the flow area of the tap and seal it with the lid.

Do not touch the lid or interior of the cap as this may introduce bacteria and affect the sample results.

9. Place the sample bottle in a cold area such as a fridge or cooler with ice. Do not store the sample bottle in a freezer.
10. Complete the paperwork provided by the laboratory.
11. Submit the sample bottle and the paperwork to the drop off location specified on the paperwork within 24 hours after the sample of water was collected. Ensure the sample is placed in a cool area such as a cooler with ice during transportation to the drop off location.
12. If sample analysis reports no *E. coli* or total coliform bacteria, repeat the above 11 steps twice more with a 1 to 3 week interval between sample collections. If sample analysis reports *E. coli* or total coliforms see the section Interpretation of Laboratory Analysis below.

INTERPRETATION OF LABORATORY ANALYSIS

The Ontario Drinking Water Quality Standards require that drinking water be free of total coliforms and *E. coli*[24].

If the three test results report no *E. coli* or total coliform present, then the well water has been successfully disinfected.

If the test results show the presence of indicator organisms, take further action. The Public Health Unit can assist the well owner or the person constructing the well with an interpretation of the test results. Some options include:

- Re-sample the well to verify the initial sample results.
- Sample for various chemical or bacterial parameters. If the presence of indicator organisms were confirmed, hire a *Professional Geoscientist* or *Professional Engineer*. The professional can identify the source of contamination and then provide recommendations to prevent it from accessing the well.
- Consult with a water treatment specialist to remove the contaminant from the drinking water.

The problem will not be resolved if water treatment is pursued without identifying and addressing the source of contamination.

Remember the well owner must abandon a well that is producing water with total coliforms, *E. coli* or other Ontario Drinking Water Quality parameters that exceed maximum acceptable concentrations found in Ontario Drinking Water Quality Standards (Ontario Regulation 169/03). The well owner is exempt from this requirement if the well owner immediately seeks the advice of the local Medical Officer of Health (Public Health Unit), follows the directions of the local Medical Officer of Health and ensures that the measures taken are functional at all times. As another alternative the well owner can seek written consent from the Director not to abandon the well (see Chapter 14*: Abandonment: When to Plug & Seal Wells*).

If the results show that the drinking water contains no significant evidence of bacterial contamination, then it is recommended that the water be tested at least three times per year. One of the three samples sent for testing should be taken in the spring.

[24] Ontario Drinking Water Quality Standards (Ontario Regulation 169/03 made under the Safe Drinking Water Act, 2002)

Director's Written Approval to Use An Alternate Method

The **Wells Regulation** requirements for well disinfection using free chlorine are not required to be followed if the Director gives written approval for another method of disinfection and the approval method is properly followed by the person constructing the well. If the person constructing the well intends to use an alternate method of disinfection, then written approval must be received from the ministry prior to constructing or altering a well including the installation of a pump.

Where Does the Person Constructing the Well Have to Go to Seek a Written Approval From the Director?

If a person constructing the well wishes to seek the written approval of the Director to use another method of disinfection the person constructing the new well or altering the existing well, including installing a pump may contact the Water Well Help Desk:

- In writing to Water Well Help Desk, Environmental Monitoring and Reporting Branch of the Ministry of the Environment , 125 Resources Road, Etobicoke ON M8P 3V6;
- By telephone at 1-888-396-9355 (for Ontario residents only);
- By fax at: 416-235-5960; or
- By e-mail at: helpdesk@waterwellontario.ca

What Information is needed for a Written Consent?

The ministry assesses each case individually and on its merits. As a minimum, applicant's contacting the ministry for a written consent should provide a written request with the following information:

- the name of the individual(s)/entity that owns the well,
- the location of the well,
- an indication as to whether or not the well in question is new or an existing well,
- the purpose of the well,
- the justification as to why the well needs to be disinfected using another method,
- an overview of the proposed alternate method,
- written certification by the manufacturer or retailer that the alternate disinfection process will be effective in disinfecting the well, and
- historical and current water quality information for both raw and treated samples of the water extracted from the well in question if applicable.

If well design, water quality or gas issues exist, a well owner or the person constructing the well may be required to retain a *Professional Engineer or Professional Geoscientist* who would have to prepare a scientific report showing the appropriate scientific rationale to support the application. The person would have to submit the report along with the request for written approval to the ministry for its consideration.

The ministry may ask other regulators and interested parties to comment on the application.

How Does the Director's Decision Process Work?

The request for written consent should be submitted to the ministry along with any and all supporting documents such as a hydrogeological and/or a well design report. Well owners and others should be cautioned that obtaining a written consent will not be a simple and automatic process since the ministry has to provide for the conservation, protection and management of Ontario's waters and for their efficient and sustainable use, to promote Ontario's long-term environmental, social and economic well-being.

The Director will review the request, supporting information and other information generated from internal and external parties with an interest in the application.

Based on the information, the Director will contact the well owner in writing indicating the Director has decided to:

- Issue the written consent to the well owner and the person constructing the well
- Refuse to approve the alternate method and thus, the **Wells Regulation** disinfection requirements must be followed or
- Request additional information from the well owner to allow the Director to make a decision

Alternate Method When Arsenic is Present

The Director recognizes that in parts of the Canadian Shield area of Ontario, elevated levels of naturally occurring arsenic can occur in igneous or metamorphic bedrock. In such circumstances, the high pH that may result from chlorination may cause arsenic to leach into groundwater and water supplies (see Chapter 4: *Siting the Well* for further information on identifying problems with groundwater). The Director will consider giving written approval in areas where elevated levels of arsenic may occur if a person follows "Best Management Practice - Alternate Chlorination Approach When Arsenic is Present."

Best Management Practice – Alternate Chlorination Approach When Arsenic is Present

The Director would consider giving advance written approval if the person disinfecting the well demonstrates that arsenic is either present or known to be present in the area and follows:

- the application process,
- all of the requirements for Well Disinfection in the **Wells Regulation** except that the concentration of the free chlorine is not less than 50 milligrams per litre and not more than 100 milligrams per litre and the free chlorine in the well is pumped after 30 minutes of chlorination, and
- the Bacterial Sampling Best Management Practice below.

Alternate Method When Person Cannot Maintain a 50 mg/L Free Chlorine Residual for at Least 12 hours

The Director recognizes that in some bedrock wells, chlorinated water will move away from the well into the aquifer and the person can not maintain a free chlorine residual of at least 50 mg/l. The Director will consider giving written approval where the person has followed the **Alternate Chlorination Approach When 50 mg/L of Free Chlorine cannot be Maintained for at Least 12 hours Best Management Practice**.

Best Management Practice – Alternate Chlorination Approach when 50 mg/L of Free Chlorine Cannot be Maintained for at Least 12 hours

The Director would consider giving advance written approval if the person disinfecting the well demonstrates that s/he can not maintain a free chlorine residual of at least 50 mg/L over at least a 12 hour period, and follows:

- The application process
- All of the requirements for Well Disinfection in the **Wells Regulation** except that the concentration of the free chlorine residual after 12 hours can be less than 50 milligrams per litre
- The Bacterial Sampling best management practice below

Alternate Method – Bacterial Sampling

The following Bacterial Sampling best management practice is part of the alternate disinfection methods discussed above.

Best Management Practices – Bacterial Sampling

- The person constructing the well should sample the well for total coliforms and *E. coli* bacteria one week after the heavily chlorinated water has been pumped from the well, pumping equipment and plumbing.
- The person constructing the well should submit all samples to a public health laboratory or an accredited and licensed private laboratory. The laboratory must analyze the samples for bacterial indicator parameters.
- The person constructing the well should ensure all laboratory findings and reports are delivered to the well owner and, where applicable, the well purchaser.
- If the sample analysis shows indicator bacteria are not present the person constructing the well must obtain one more sample for total coliforms and *E. coli* bacteria analyses and the sample should be taken between one to two weeks after the initial sample.
- The person constructing the well should submit all additional samples to a public health laboratory or an accredited and licensed private laboratory. The laboratory should analyze the samples for bacterial indicators.
- The person constructing the well should ensure all additional laboratory findings and reports are delivered to the well owner and, where applicable, the well purchaser.
- If indicator bacteria are present, the person constructing the well should provide the well owner, and where applicable, the well purchaser with the documentation that the well owner must abandon a well that is producing water with total coliforms or *E. coli*. The well owner is exempt from this requirement if the well owner immediately seeks the advice of the local Medical Officer of Health (Public Health Unit), follows the directions of the local Medical Officer of Health and ensures that the measures taken are functional at all times. As another alternative, the well owner can seek written consent from the Director not to abandon the well (see Chapter 14: *Abandonment: When to Plug & Seal Wells*).

Alternate Method When Petroleum Hydrocarbons, Solvents or other Contaminants are Present

The Director recognizes that in areas contaminated with petroleum hydrocarbons, solvents or other contaminants, reactions with chlorinated water can create other chemicals which can be dangerous or hazardous.

Best Management Practice – Disinfecting when Petroleum Hydrocarbons, Solvents or other Contaminants are Present

The Director would consider giving advance written approval not to follow the disinfection requirements in the **Wells Regulation** for the time period that the contaminant is impairing the well water if a person constructing a well follows the application process and provides evidence (e.g. laboratory sample analysis reports and an interpretation of the reports) that the area and groundwater are contaminated with petroleum hydrocarbons, solvents or other contaminants.

9. Equipment Installation

Chapter Table of Contents

Chapter Figures

Chapter Tables

CHAPTER DESCRIPTION

This chapter details the requirements for the installation of pumps, caps, covers, vents and other equipment in or connected to wells. This chapter also describes and illustrates various pump types and other equipment that are installed in or connected to different well types.

REGULATORY REQUIREMENTS – EQUIPMENT INSTALLATION

RELEVANT SECTIONS – THE WELLS REGULATION

Ontario

Installation of Equipment – Sections 15.2 – 15.3

Venting – Section 15.1

Surface Drainage – 12.3

Disinfection – Section 15

Well Pits – Subsections 12(7) -12(9) and Section 14.5

THE REQUIREMENTS – PLAINLY STATED – INSTALLING EQUIPMENT

Ontario

The Wells Regulation Provides the Following Exemptions when Equipment is Installed

Exemptions for Equipment and Activities

Licensing Requirements in the O*ntario Water Resources Act* and the requirements in the **Wells Regulation** do not apply to any of the following activities that are part of the construction of a well:

- Inspecting the well using equipment that is not left unattended in the well
- Monitoring, sampling or testing the well using equipment that:
  - is not used to test the yield of the well or the aquifer, and is not left unattended in the well; or
  - is not used to test the yield of the well or the aquifer, and was previously installed in the well.
- Installing equipment for monitoring, sampling or testing a test hole or dewatering well, unless the:
  - installation of the equipment involves an alteration of the well, other than notching the top of the casing; or
  - equipment is used to test the yield of the well or the aquifer.

However, all equipment installed in a well must not cause or have the potential to cause impairment to the water in the well or the groundwater as required under subsection 30(1) of the *Ontario Water Resources Act*.

The Wells Regulation Requires the Following when Installing Equipment

Equipment in a Well

Any equipment installed in a well must be clean.

Connections to Drilled Wells

If a connection to the casing of a drilled well is made below the ground surface, a well seal or pitless adapter must be used and the connection must be made watertight.

Pitless units, which consist of a pitless adapter and casing, are also an acceptable method to connect pumping equipment to drilled wells.

A cutting torch must not be used to make an opening in the casing wall when installing a pitless adapter.

Connections to Wells Other than Drilled Wells

Any below ground connection to the casing of a well, must be made watertight with durable bonding material.

Excavation Beside the Casing

Any outside excavation created when making a below ground connection to the casing of a well must be filled with suitable sealant extending from the casing a minimum distance outward of 20cm (8″) and extending from the bottom of the excavation to within 20cm (8″) of the ground surface.

Venting- General

If a new well is constructed by any method, the well must be vented to the outside atmosphere so that all gases can be safely dispersed

Venting – Pump Installation

If a pump is installed in a drilled well:

- An air vent must be installed with a minimum inside diameter of:
  - 0.3 cm, (0.11″) if the inside diameter of the casing is less than 12.7 cm (5″), or
  - 1.2 cm, (0.48″) if the inside diameter of the casing is 12.7 cm (5″) or more.
- The air vent must be long enough to extend above the covering of the well pit, if a well pit exists, or extends above the ground surface at least 40 cm (16″) at a distance sufficient to prevent the entry of flood water from any anticipated flooding in the area, if no well pit exists, and
- The open end of the air vent must be shielded and screened to prevent the entry of any materials into the well.

Venting Air Line in Well Pit

- The vent requirements of pump installation for a drilled well do not apply to a well with a well pit if there is no potential hazard from natural gas or any other gas. However, an air vent line must be installed on a new drilled well in a new well pit (only allowed if created by diamond drilling equipment in connection with mineral exploration) and must extend above the cover of the well pit (see Pump Installation for a Drilled Well in this chapter and Well Pits, below).

Covering the Well

Dug or Bored

The top of the casing of a well that is constructed by digging or boring must be covered with a solid, watertight well cover, so that surface water and other foreign materials can not enter into the well.

Drilled or Other

The top of the casing of a well that is not constructed by digging or boring must be sealed with a commercially manufactured vermin-proof well cap (this includes a properly installed and sealed sanitary well seal and a watertight and airtight well cap for a point well).

Alternative to a Well Cover

The cover or seal above is not required if all of the following criteria are met:

- A floor has been constructed around or adjacent to the casing of the well,
- A pump (includes associated equipment such as water lines) is installed above or adjacent to the well,
- The top of the casing is shielded to prevent entry of any material that may impair the quality of the water in the well, and
- The casing of the well is extended to at least 15 cm (6″) above the floor.

The installation of a well cap or watertight well cover is considered a "minor alteration" to a well.

Disinfection:

- As soon as possible after the construction or installation is complete, the water in the well must be dosed to a concentration of not less than 50 milligrams per litre and not more than 200 milligrams per litre of free chlorine (See Chapter 8: *Well Disinfection* for further details).

The requirements for casing height for new wells are provided in the "Plainly Stated" section of Chapter 7: *Completing the Well's Structure* and the requirements for not reducing a casing above the ground surface are provided in the "Plainly Stated" section of Chapter 11: *Maintenance & Repair*.

Well Pits

A new well must not be constructed with a well pit, and a well pit must not be added to an existing well, at any location unless a new or existing well was created by diamond drilling equipment in connection with mineral exploration.

The Following Requirements Apply to a New Well Pit for a New or Existing Well Created by Diamond Drilling Equipment in Connection with Mineral Exploration

Walls (or Casing)

The walls of the well pit are considered casing.

The casing requirements found in Chapter 5: *Constructing and Casing the Well* and Chapter 7: *Completing the Well's Structure* of this manual must apply to the sides of a well pit including the top of the casing being at least 40 cm (18″) above the highest point on the ground surface within 3 m (10′) radially from the outside of the well pit's casing.

Surface drainage must not collect or pond in the vicinity of the well pit's casing.

Well Pit Floor

The floor of the well pit must be covered with at least 10 cm (4″) of suitable sealant that is capable of supporting the weight of a person.

Creating and Filling the new Well Pit's Annular Space

The person constructing the well must ensure that the entire well pit, from the bottom of the well pit to the ground surface, is constructed with a diameter that is at least 7.6 cm (3″) greater than the outside diameter of the well pit's walls (or casing).

The person constructing the well must ensure that any annular space outside the well pit's casing is filled, from the bottom of the well pit to the ground surface, with suitable sealant.

The sealant must provide the appropriate structural strength to support the weight of persons and vehicles that may move over the area after it is filled.

If the sealant contains cement:

- It must be allowed to set according to the manufacturer's specifications or for 12 hours, whichever is longer, and
- If, after setting, the sealant has settled or subsided, it must be topped up to the ground surface.

Cover/Seal for a Well Located in a New Well Pit

The top of the casing of the diamond drilled well in the new well pit must be:

- at least 40 cm above the floor of the well pit, and
- sealed with a commercially manufactured sanitary seal. An air vent must be provided from the seal to above the covering of the well pit (see the section titled: "Venting Air Line in Well Pit," on page 7 of this chapter, for further information).

Well Pit Cover

The top of the well pit must be covered with a solid, watertight cover.

The well pit cover must be sufficiently sealed to prevent the entry of surface water and other foreign materials including insects, animals and persons.

The cover on the well pit must be fastened to the sides of the well pit in a manner that will make it difficult for children to remove the well pit cover.

Keeping the Well Pit Dry

The well pit must be kept dry by means of a sump pump unless the water table is substantially lower than the floor of the well pit

If the water table is substantially lower than the floor of the well pit, the well pit may be kept dry by means of a drainage pipe from the well pit that:

- Has a one-way valve to allow water to discharge from the pit but prevents surface water and other foreign materials, including insects, animals and persons, from entering the well pit,
- Passes through the layer of sealant, and
- Allows water to discharge near the perimeter of the well pit.

Venting the Well Through the Well Pit

See "Venting Air Line in Well Pit" on page 7 for further information.

Surface Drainage:

- The mounding of the ground surface beside the well must be done so that surface drainage does not pond or collect in the vicinity of the well. Additional information on surface drainage can be found in Chapter 7: *Completing the Well's Structure*.

Relevant Sections – Additional Regulations or Legislation

Ontario Regulation 164/99 as amended (Electrical Safety Code) made under the *Electricity Act*, 1998. S.O. 1998. Chapter 15, Schedule A;

Ontario Regulation 632/05 as amended (Confined Spaces) made under the *Occupational Health and Safety Act*, R.S.O. 1990, Chapter 0.1;

Ontario Regulation 213/91 as amended (Construction Projects) made under the *Occupational Health and Safety Act*, R.S.O. 1990, Chapter 0.1;

Relevant Guidance Documents

Fleming College. 2008. Manual for Continuing Education Course *Safety (for Ontario Well Technicians).*

WSC PAS-97(04) – "WSC Performance Standards and Recommended Installation Procedures for Sanitary Water Well Pitless Adapters, Pitless Units, and Well Caps." Water System Council, Washington DC. http://www.watersystemscouncil.org/

FIGURE 9-1: RELEVANT SECTIONS OF WELL RECORD – LOGISTICS

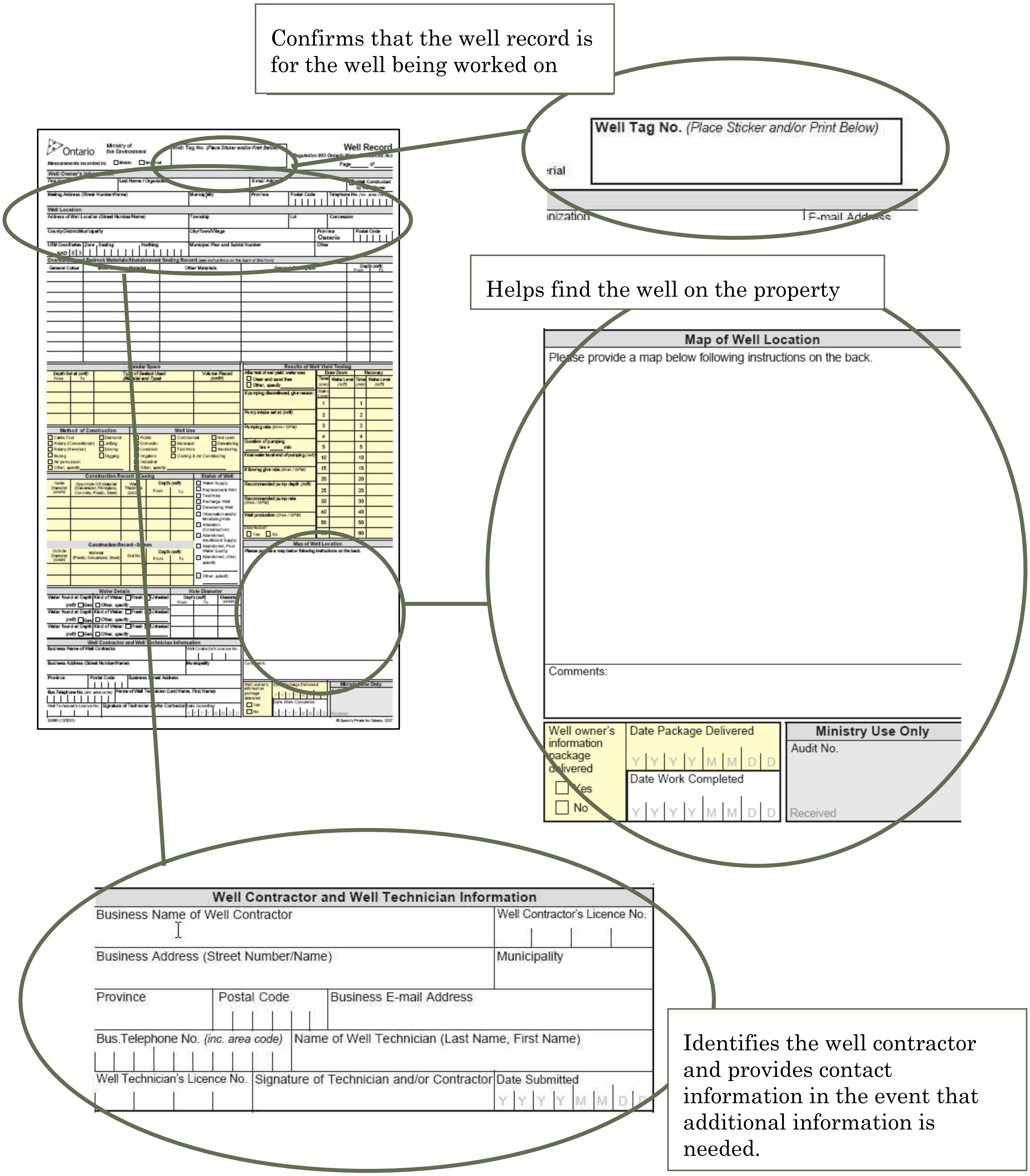
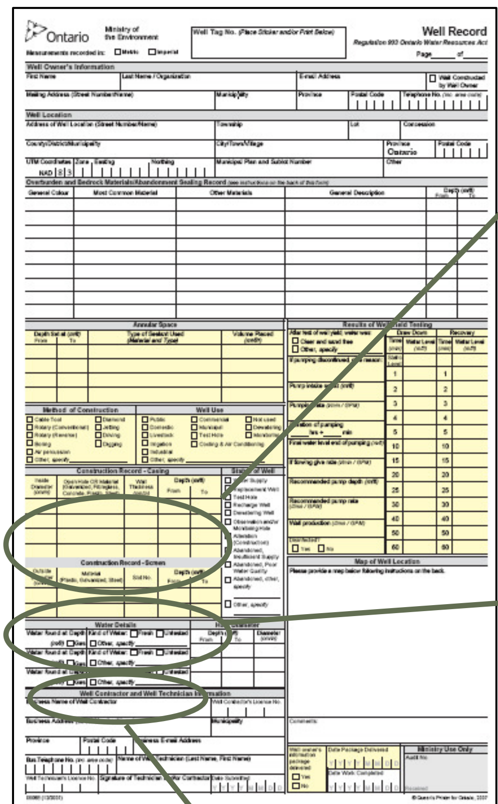


FIGURE 9-2: RELEVANT SECTIONS OF WELL RECORD – CONSTRUCTION

Well Casing:

- Important for clearance (i.e. well diameter) with down hole components (e.g. submersible pump)
- Identifies where casing ends or open hole starts/ends



Construction Record - Casing

Inside Diameter *(cm/in)*	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness *(cm/in)*	Depth *(m/ft)* From	Depth *(m/ft)* To

Construction Record - Screen

Outside Diameter *(cm/in)*	Material (Plastic, Galvanized, Steel)	Slot No.	Depth *(m/ft)* From	Depth *(m/ft)* To

Well Screen:

- Identifies if a well screen is present and its length, slot size and depth
- Helps ensure that the pump intake is installed above the top of the well screen

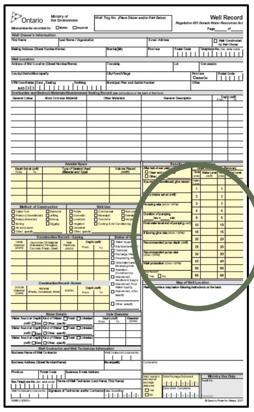
Water Details

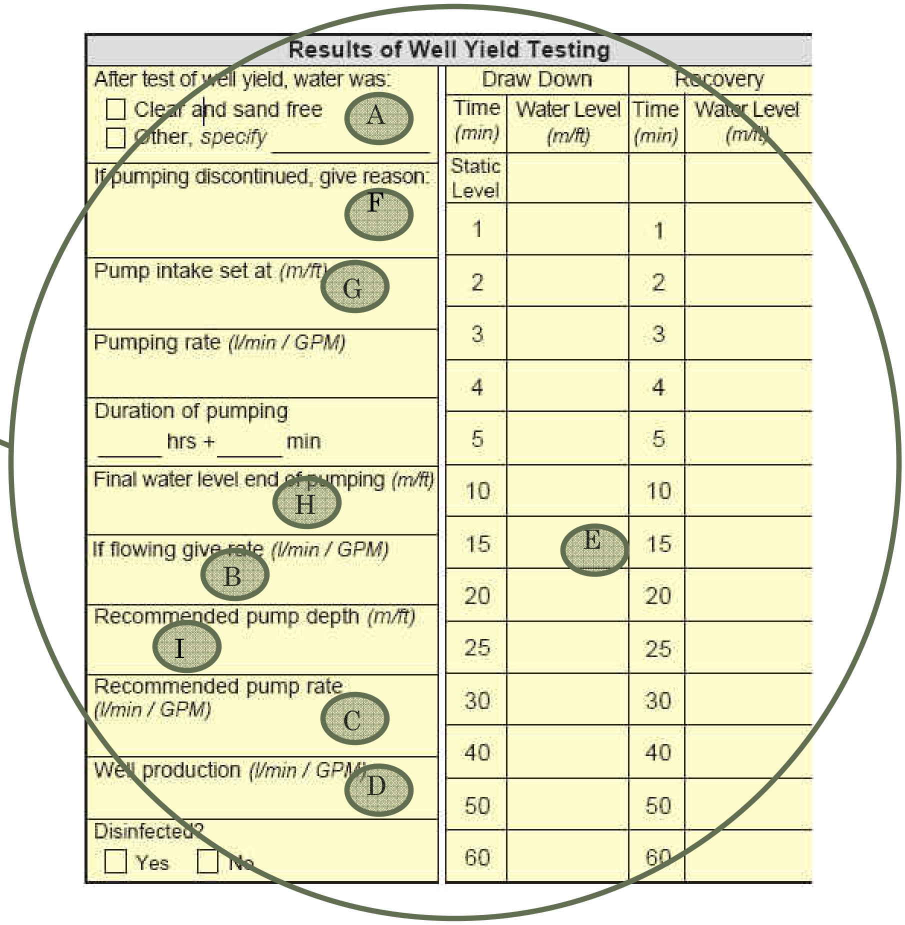
Water found at Depth *(m/ft)* ☐ Gas	Kind of Water: ☐ Fresh ☐ Untested ☐ Other, *specify* ________
Water found at Depth *(m/ft)* ☐ Gas	Kind of Water: ☐ Fresh ☐ Untested ☐ Other, *specify* ________
Water found at Depth *(m/ft)* ☐ Gas	Kind of Water: ☐ Fresh ☐ Untested ☐ Other, *specify* ________

Water Details:

- Identifies location of groundwater intersected by the well
- Identifies gas that could affect pumping and cause problems or hazards in the water distribution system and well site
- Provides general remarks on the quality of water observed

FIGURE 9-3: RELEVANT SECTIONS OF WELL RECORD – RESULTS OF WELL YIELD TESTING





A – After Test of Well Yield:

- Indicates if there is particulate such as sand or silt in the well.
- If particulate is present then take appropriate measures to remove it from the water distribution system and install appropriate pumping equipment for these conditions.

B – If Flowing Give Rate (see Chapter 12: *Flowing Wells* for additional details on equipment installation in flowing wells):

- If flowing conditions are encountered during construction:
  - The person constructing the well must install an appropriate device to control the discharge of water.
  - The person installing equipment in the well should ensure that the device installed to control the discharge remains intact or is properly re-installed after equipment installation.

C – Recommended Pumping Rate:

- Indicates recommended yield to determine appropriate pump size.

D – Well Production:

- Do not use this value to size the pump as it may result in the well producing sand (e.g. well produces 29 GPM but only sand free at 7 GPM).

E – Drawdown/Recovery Columns:

- Assists in the determination of the well's efficiency, appropriate pump size and intake elevation.

F – If Pumping Discontinued, Give Reasons:

- Indicates reason pumping did not last one hour. The reasons may indicate that the test may be suspect or the well may be low yielding.

G – Pump Intake Set At:

- Indicates the elevation of the pump intake during the test.

H – Final Water Level:

- Measured at the end of the pumping test and can be used to determine the appropriate pump size and location.

I – Recommended Pump Depth:

- Values and locations are estimated by person constructing the well based on the results of the yield test.
- The installer should consider all of the information from the well yield test when determining appropriate pump size, pump rate and intake location.

Key Concepts

What to Consider When Installing Equipment

It is important to consider the protection of health, safety and the environment when installing equipment. The following requirements are relevant to the installation of equipment:

- Anything that is put into the well must not impair the quality of the water
- The sanitary well seal, cover or cap must be properly secured on the top of the well
- There must be no points of entry to allow contamination (e.g. chemicals, small animals, etc.) into the well
- Any space around the waterline through the casing or through the top of the casing must be properly sealed
- The final grade of the ground surface must allow for the proper height of casing and must not allow ponding of water in the vicinity of the well.

Connections to Wells

Connections may be required for a well to function properly. Connections can be made above and below the ground surface to accommodate waterlines or instrumentation to enter a well. Connections below the ground surface must be made watertight to avoid contamination of both the well and the aquifer.

Venting

The purpose of the vent is to allow the well to breathe, which allows equalizing pressures (i.e. when water is drawn out, air goes in so the column of water is at atmospheric pressure at all times) and the safe venting of natural and other gases to the outside atmosphere.

Well Caps and Covers

Proper covering of the well prevents the entry of foreign materials into the groundwater.

Securing the well is a safeguard against unauthorized entry into the well, vandalism or tampering. Securing the well includes ensuring that the well cap, seal or cover is on properly and may include the use of a protective cover with locking cap, barriers or fences. For information on securing the well refer to Chapter 7: *Completing the Well's Structure*.

Casing Height & Mounding

The purpose of the minimum casing height is to prevent water from entering the well and to allow for venting. The purpose of mounding is to reduce the risk of surface water runoff ponding in the vicinity of the well and infiltrating into the well.

When installing or connecting equipment, it is important that the minimum casing height be maintained and that the mounding around the well be restored if it has been disturbed.

WELL PITS

Well pits are an enclosed structure, located at and below the ground surface that houses the top of the well and any associated pumping equipment. The top of the well casing extends out of the floor of the well pit.

Well pits are usually installed at or near the time of pump and associated equipment installation in the well.

HEALTH AND SAFETY CONSIDERATIONS – TRENCHES, CONFINED SPACES AND ELECTRICAL

The safety manual from the well drilling continuing education course provides details regarding safety when excavating or working in trenches and confined spaces, along with precautions for working with or around electrical lines. This manual is available from Sir Sanford Fleming College (see the "*Resources*" section). It is recommended that these guidelines be reviewed prior to taking on any related tasks. Failure to be aware of the surroundings and follow appropriate safety procedures could result in serious injury or death.

INSTALLING PUMPING AND OTHER EQUIPMENT

Ontario

The **Wells Regulation** exempts any of the following activities that are part of the construction of a well:

- Inspecting the well using equipment that is not left unattended in the well.
- Monitoring, sampling or testing the well using equipment that:
  - is not used to test the yield of the well or the aquifer, and is not left unattended in the well; or
    - is not used to test the yield of the well or the aquifer, and was previously installed in the well.
- Installing equipment for monitoring, sampling or testing a test hole or dewatering well, unless:
    - the installation of the equipment involves an alteration of the well, other than notching the top of the casing; or
    - the equipment is used to test the yield of the well or the aquifer.

Ontario

Except for the above activities, any equipment installed in a well must be clean as required by the **Wells Regulation**. Despite the exemption from the regulatory requirements, all equipment installed a well must not cause or have the potential to cause impairment to the water in the well or the groundwater (under subsection 30(1) of the *Ontario Water Resources Act)*

Best Management Practice – Installing Equipment

Anyone constructing a new well or working on an existing well should:

- Install new parts, devices and materials in drinking water wells that are certified to meet the National Sanitation Foundation (NSF) International Standard 61 Drinking Water System Components – Health Effects1. Verify the components are certified by searching on the NSF 61 Products and Services Database (http://www.nsf.org/Certified/PwsComponents) and by looking for the NFS logo on the equipment.
- Install parts, devices and materials that are suitable for the particular type of environment and well.
- Clean the equipment with chlorinated water as suggested by AWWA C654 standard titled Disinfection of Wells or the Michigan's Water Well Disinfection Manual if necessary.
- Ensure parts are installed to the manufacturer's specifications.

Best Management Practice – Have Well Record on Hand

The person installing the pump should have the well record and the information on Figures 9-1 to 9-3 available any time pump work or other equipment installation is carried out on a well.

[1] NSF International Standard/American National Standard 61, 2008. "*Water Treatment and Distribution Systems - Health Effects*," NSF International, Ann Arbor, MI 2008.

Pump Terms & Facts

A water well pump is designed to move water by a physical or mechanical action.

Pump includes associated pumping equipment

Horsepower of the pump, outlet pressure in metres (or feet) of head, rate of water flow and inlet suction in metres (or feet) of head are key factors in selecting a pump. The head is considered the height the pump can raise a column of water at atmospheric pressure. Pressure is the amount of force acting on a unit area. Two units that may be used to describe pressure are psi (pounds force per square inch), and kPa (Kilopascals).

To select the type of pump, a system curve graph is created describing the relationship between the system's head and flow rate. Also a pump performance curve graph is created describing the relationship between the head versus the flow rate of the pump. By combining the two graphs, the pump type, horsepower and best operating system can be selected. Further information on pump selection may be found in *Groundwater and Wells,* Third Edition, 2007.[2]

Table 9-1 provides common acronyms for flow rate and head parameters used in the installation of pumps and associated equipment. Table 9-2 on the next page provides pressure to head conversions used in pump selection.

Table 9-1: Acronyms for Head and Rate

Acronym	Term
m of head	Metres of head above pump intake
′ of head	Feet of Head above pump intake
TDH	Total Dynamic Head = Service pressure + pumping level + elevation + friction loss
LPH	Litres per Hour
LPM	Litres per Minute
GPH	Gallons per Hour
GPM	Gallons per Minute

[2] Sterrett, Robert J. 2007. *Groundwater and Wells; Third Edition.* Johnson Screens/a Weatherford Company. New Brighton, MN.

Table 9-2: Pressure to Head Conversions Used in Pump Selection

	PSI (pounds/square inch)	**kPa (kilopascals)**
Conversion between units	1PSI = 6.9kPa	1kPa = 0.145PSI
Pressure of a column of water	= head in meters x 1.422 (1m of head = 1.422 PSI)	= head in meters x 9.807 (1m of head = 9.807 kPa)
	= head in feet x 0.432 (1′ of head = 0.432 PSI)	= head in feet x 2.989 (1′ of head = 2.989 kPa)
Metres of head of a column of water per unit of pressure	= pressure (PSI) x 0.703 (1 PSI = 0.703 m of head)	= pressure (kPa) x 0.102 (1kPa = 0.102 m of head)
Feet of head of a column of water per unit of pressure	= pressure (PSI) x 2.31 (1 PSI = 2.31′ of head)	= pressure (kPa) x 0.335 ("ahead of" 1kPa = 0.335′ of head)
Distance column of water raised per unit of pressure	1 PSI will raise a column of water 0.703 m (2.31′); regardless of the column's diameter.	1kPa will raise a column of water 0.1 m (0.335′); regardless of the column's diameter.
Atmospheric Pressure and Head at sea level	14.7PSI * (14.7 PSI x 0.703=10.34 m of head) (14.7 PSI x 2.31 = 33.95 ft of head)	101.35kPa * (101.35kPa x 0.102 = 10.34m of head) (101.35kPa x0.335 = 33.95 ft of head)
	* This pressure will maintain a column of water 10.34 m (33.9′) high when the normal pressure in the column is relieved by the creation of a vacuum. This is the theoretical distance that water may be drawn by suction. In practice, however, centrifugal (suction) pumps should not be placed over 6 m (20′) to 7.6 m (25′) above the water supply and nearer if possible.	

The volume and weight of water are other considerations when selecting a pump. The following are a few common facts related to the volume and weight of water when installing a pump in a well:

- An Imperial gallon of fresh water weighs 4.5 kg (10lbs).
- One litre of fresh water weighs 1 kg (2.2lbs).
- A cubic foot of water contains 0.028 cubic metres, 7.48 US gallons, or 6.24 Imperial gallons; and weighs 28.3kg (62.4 lbs).
- A cubic metre of water contains 265 US gallons or 220 Imperial gallons.
- Volume of water per metre (or foot) in some wells:
    - 10.8 cm (4.25″) inside diameter contains 9.2 litres per metre (0.61 gallons per foot)
    - 13.3 cm (5.25″) inside diameter contains 13.9 litres per metre (0.94 gallons per foot)
    - 15.9 cm (6.25″) inside diameter contains 19.9 litres per metre (1.33 gallons per foot)
    - 0.91 m (3’) diameter bored or dug well contains 656.1 litres per metre (44.0 gallons per foot)

PUMP TYPES

The major pump types that are typically installed in wells are:

- Centrifugal pumps
- Jet pumps – shallow and deep
- Submersible pumps
- Variable speed constant pressure pumps
- Deep well turbine pumps
- Vertical turbine pumps

Table 9-3 provides details for the advantages, disadvantages, general capabilities and applicable well types for these pumps.

Table 9-3: Advantages, Disadvantages and Applicable Well Types for Various Pumps

Pump Type	Advantages	Disadvantages	Average Pumping Level Capability	Applicable Well Type(s)
Centrifugal Pump	• Generally produce high volumes of water • Depending on impeller design can also pass some small solids • Simple design – no jet is used • Great for irrigation and dewatering situations because of the volumes they can move	• Only effective to a 6m (20’) lift or less • Requires a pressure tank to maintain pressure	• Up to 6 m (20′)	• Shallow Wells • Irrigation ponds • Dewatering (i.e. sump holes)
Jet Pump	• Low Cost • Higher volume capacity at low total head • Shallow well jet can be converted to deep well jet • Higher pressure can be acquired with multi-stage units • Can be offset from well • Easy to handle, service and very reliable because they have only one moving part, the impeller, which is directly connected to the motor • Require very little maintenance and have a reasonable operating life considering the workload • Deep well jet can be modified to adapt to low producing wells • Can be noisy and vibrate	• Cannot operate with air or gas in system • Difficult to prime if there is a leak in the line or if it is not level • Requires two lines for deep well jet • Easily damaged by particulate (sandy water) • As the vertical distance between the pump and water increases, the volume produced decreases • Limited depths of operation and discharge pressures • A control valve is needed on the outlet of the pump to provide a minimum back pressure of 138 kPa (20 PSI) for efficient jet operation • Requires a pressure tank to maintain pressure	• Shallow well jet pump up to 7.6 m (25’) • Deep well jet pump up to 30 m (100′) or deeper using multi-stage systems	• All well types

Pump Type	Advantages	Disadvantages	Average Pumping Level Capability	Applicable Well Type(s)
Submersible Pumps	• Has an excellent range in capacity and pressure because it pushes rather than draws water • Can be designed for large production well needs • Long lines cause few problems • Constant capacity • Can be used for shallow or deep well • Typically will not freeze • Can be installed in wells 10 cm (4″) or larger in diameter • More efficient than any other type of pump (i.e., high volumes and high pressure) with minimum horsepower • Silent running and low maintenance • Control box with electrical components located in building • Simple installation • Requires only one drop pipe (waterline)	• Loss of prime can cause damage to pump unless it is installed with low pressure protection devices (e.g. flow control valve, low water pressure switch and pump tech protection device) • Higher installation cost and initial investment • Not always easy to service and may be more expensive • Sand in water will cause pump parts to wear • If the pump intake screen becomes encrusted and flow is impaired the pump may be damaged due to cavitation • Well must be free from obstructions • May be subject to failure due to lightening strikes • Requires a pressure tank to maintain pressure	• Up to 305 m (1,000′)	• Most drilled and larger diameter wells • Not for point wells • Typically not for narrow diameter wells constructed with diamond drilling equipment

Pump Type	Advantages	Disadvantages	Average Pumping Level Capability	Applicable Well Type(s)
Variable Speed Constant Pressure Pumps (Can be submersible or jet pumps)	• All the advantages of submersible pumps or jet pumps, depending on the type, as well as the following • No water pressure fluctuation issues and thus, provides water at a constant pressure • Extra electrical consumption savings • Saves space by using small pressure tanks • Easy servicing • User friendly control unit • Easy to size and set up • No separate starter box • In rare cases, an existing pumping system can be modified to make it a constant pressure pump	• All the disadvantages of submersible pumps or jet pumps, depending on the type, as well as the following • Sensors (depending on design) can be adversely affected by waters with high mineral content • In times of electrical outages there is very little water available as the pressure tanks are generally much smaller than on other systems	• Up to 305 m (1,000′)	• Same as submersible pump or jet pumps, depending on the type
Vertical Turbine Pump	• High capacity and pressure	• Requires pump • Harder to service pump than submersible pump	• Up to 305 m (1,000′)	• Large diameter drilled wells

Graphics of Installed Pumps

The following graphics illustrate the installation layout for the following scenarios:

- Drilled Well with Shallow Jet Pump (Figure 9-4)
- Drilled Well with Deep Jet Pump (Figure 9-5)
- Drilled Well with Submersible Pump Figure 9-6)
- Dug and Bored Wells with Shallow Jet Pump (Figure 9-7)
- Dug and Bored Wells with Submersible Pump (Figure 9-8)
- Driven Point Well with Shallow Well Pump (Figure 9-9)

The graphics show examples of installation only. They are not to scale. All dimensions and locations are for illustrative purposes only. Keep in mind that each of the wells shown Figure 9-4 through Figure 9-9 may encounter conditions that may require specialized design or construction. For example:

- Flowing artesian conditions
- Presence of gas
- Breathing (Sucking & blowing) conditions where the well and aquifer formation are significantly affected by changes in atmospheric pressure

The illustrations and graphics do not depict every circumstance and do not necessarily represent full compliance with other requirements found in the **Wells Regulation**.

See the tables in the Tools Section at the end of this chapter for Drop Pipe and Down Hole Component information.

All figures and diagrams are for illustrative purposes only and do not necessarily represent full compliance with other requirements found in **the Wells Regulation**.

FIGURE 9-4: DRILLED WELL WITH SHALLOW JET PUMP

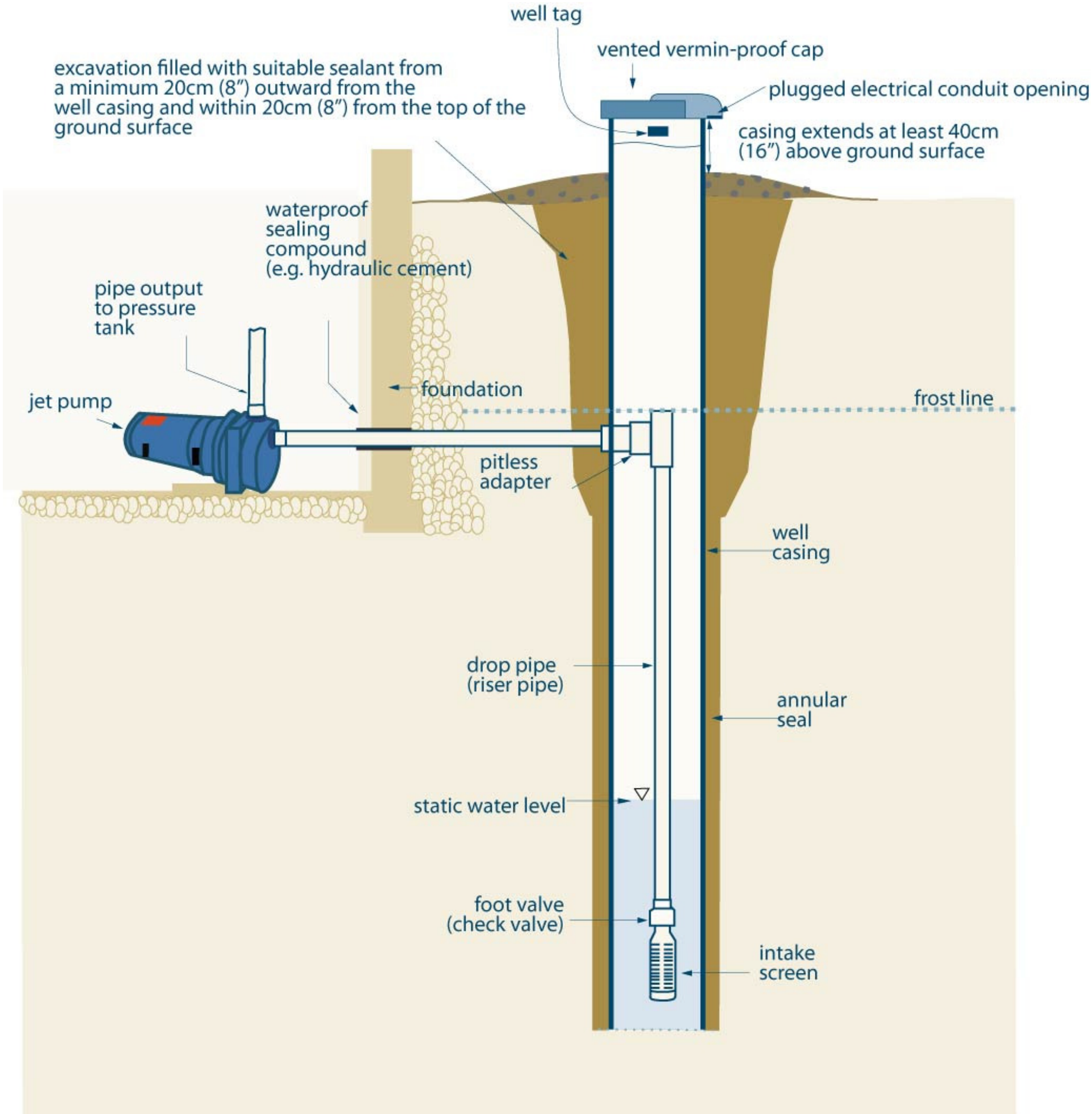


Figure 9-4 is for illustrative purposes. It does not depict every circumstance and it is not to scale.

FIGURE 9-5: DRILLED WELL WITH DEEP JET PUMP

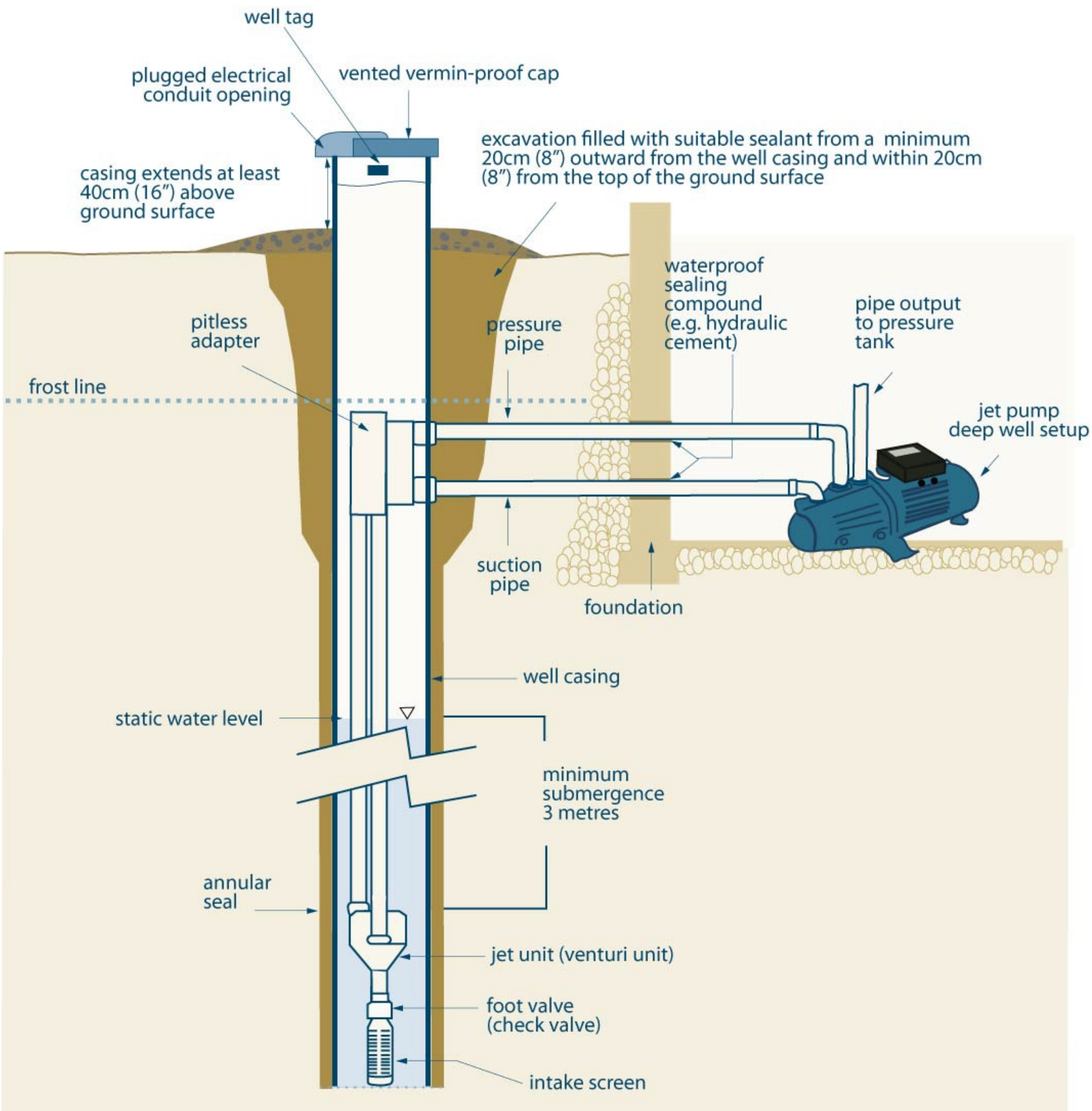


Figure 9-5 is for illustrative purposes. It does not depict every circumstance and it is not to scale.

FIGURE 9-6: DRILLED WELL WITH SUBMERSIBLE PUMP

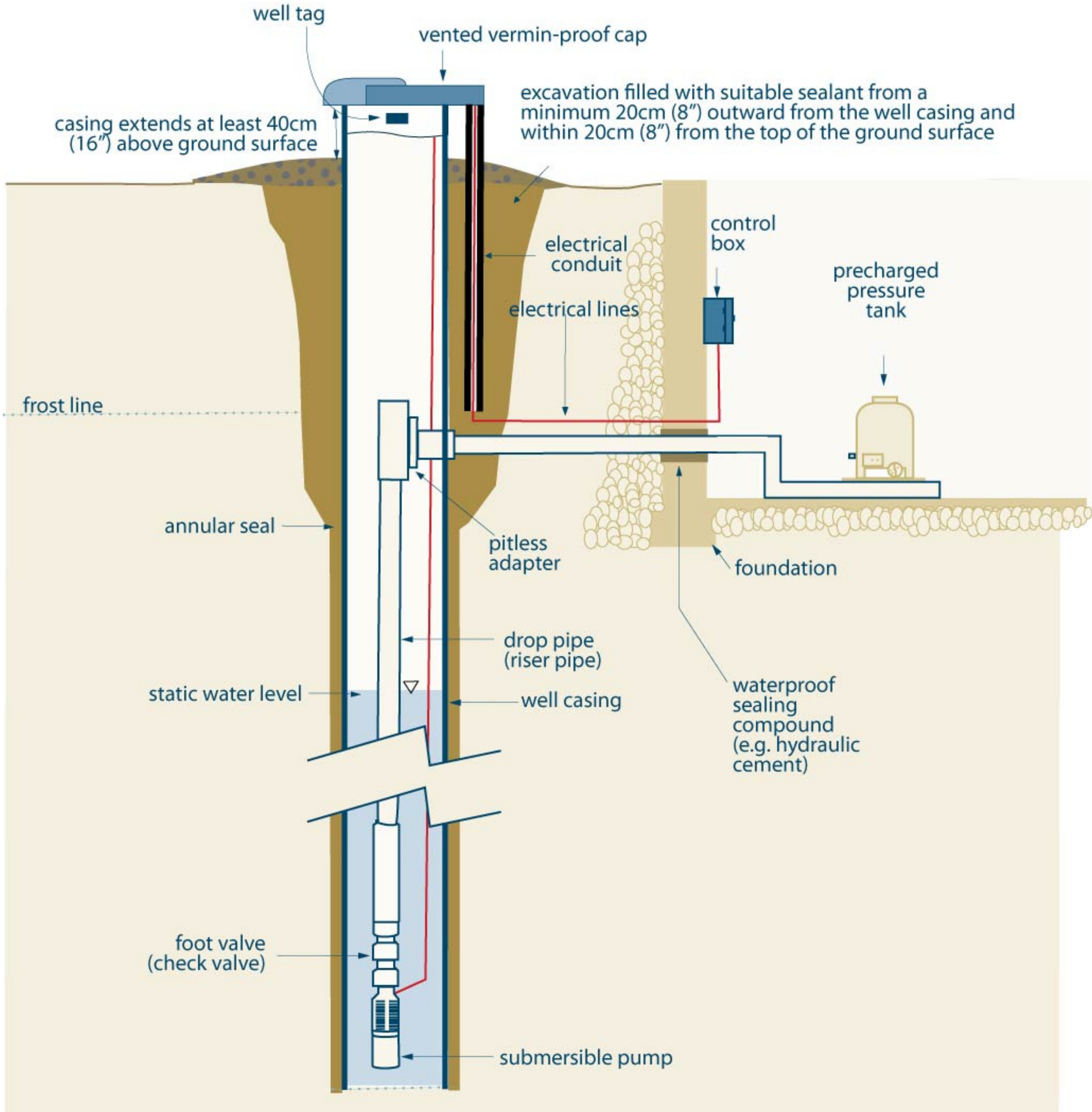


Figure 9-6 is for illustrative purposes. It does not depict every circumstance and it is not to scale.

FIGURE 9-7: DUG AND BORED WELLS WITH CONCRETE CASING AND A SHALLOW LIFT PUMP

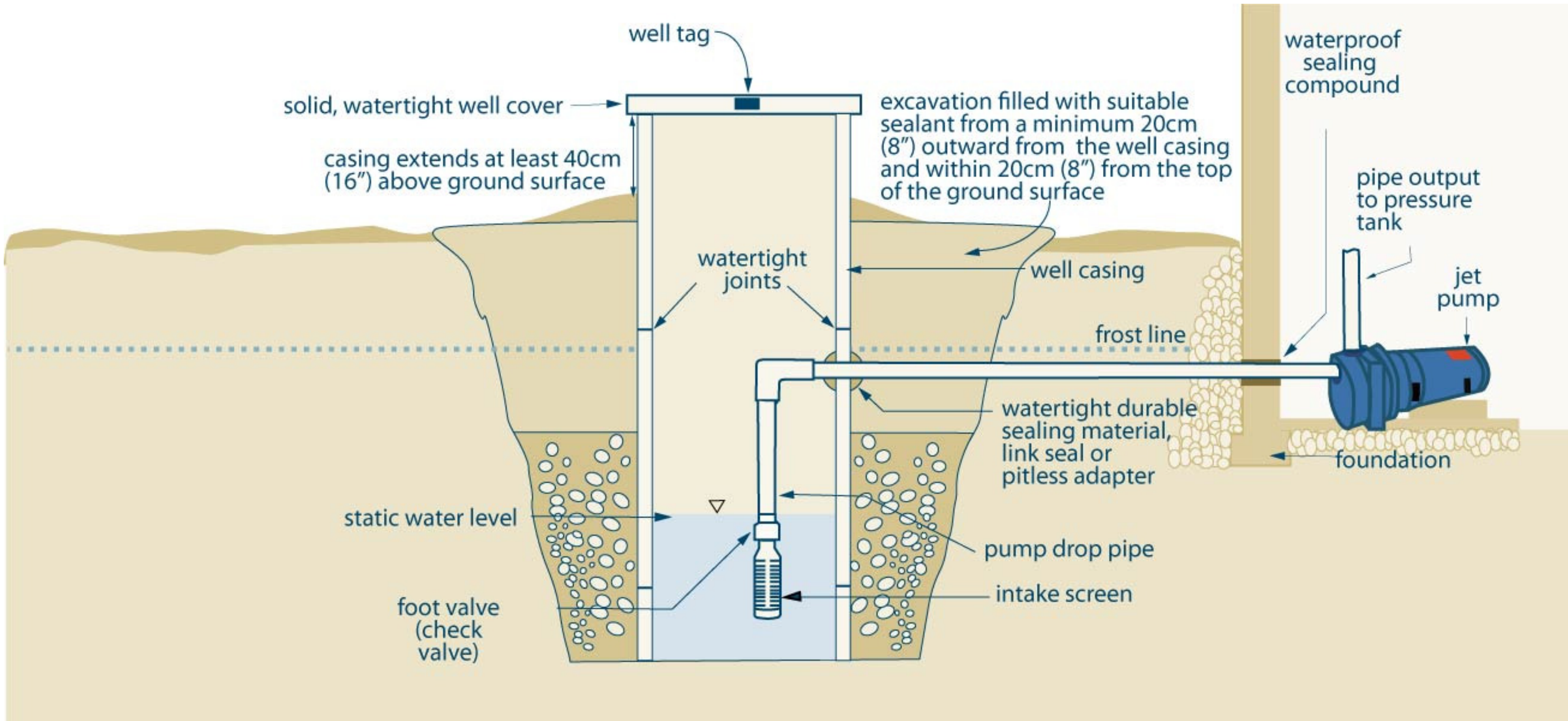


Figure 9-7 is for illustrative purposes. It does not depict every circumstance and it is not to scale.

Larger diameter wells must not be entered as they are dangerous unless adequate safety precautions are taken using Confined Spaces Regulation 632/05 under the *Occupational Health and Safety Act.*

FIGURE 9-8: DUG AND BORED WELLS WITH CONCRETE CASING AND A SUBMERSIBLE PUMP

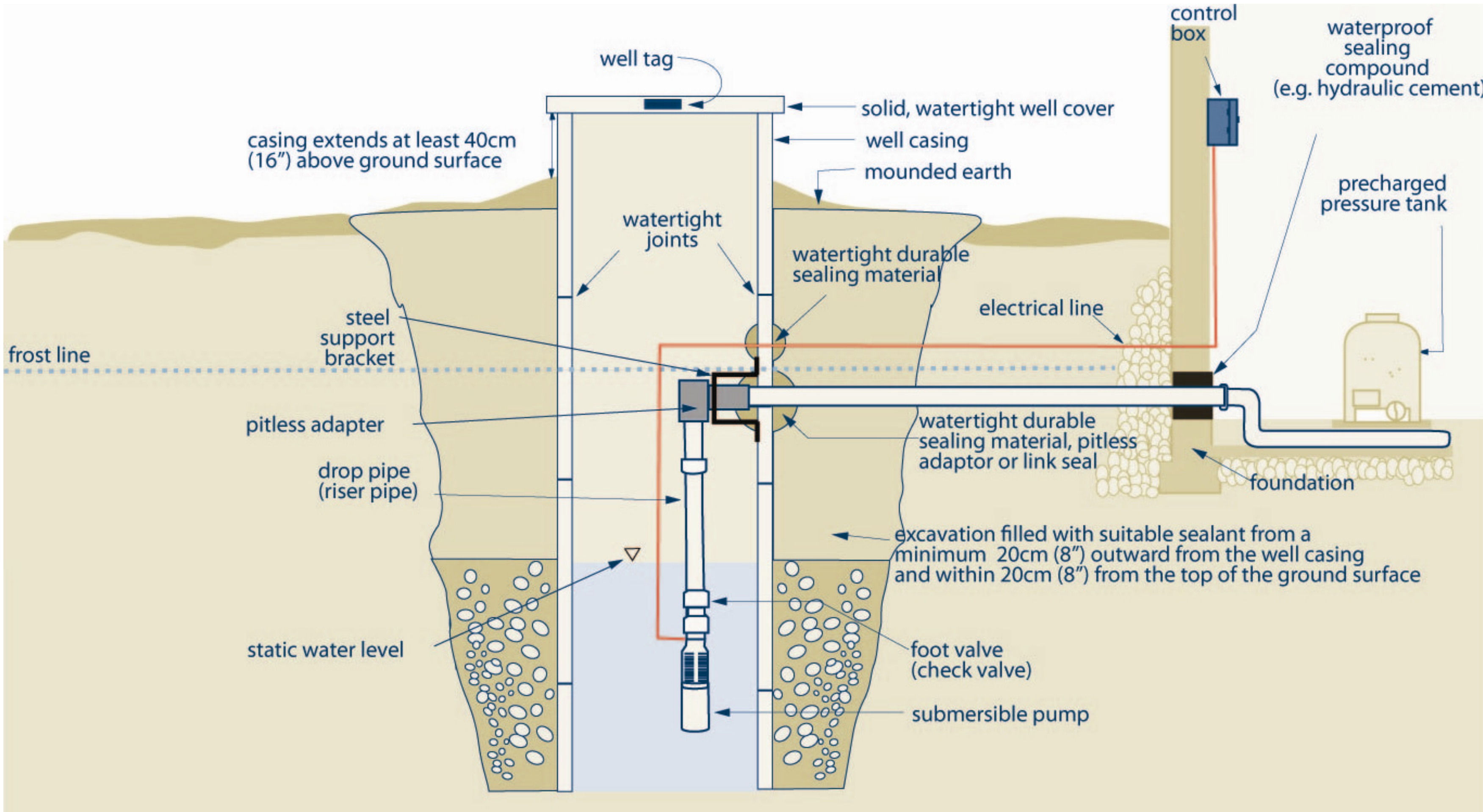
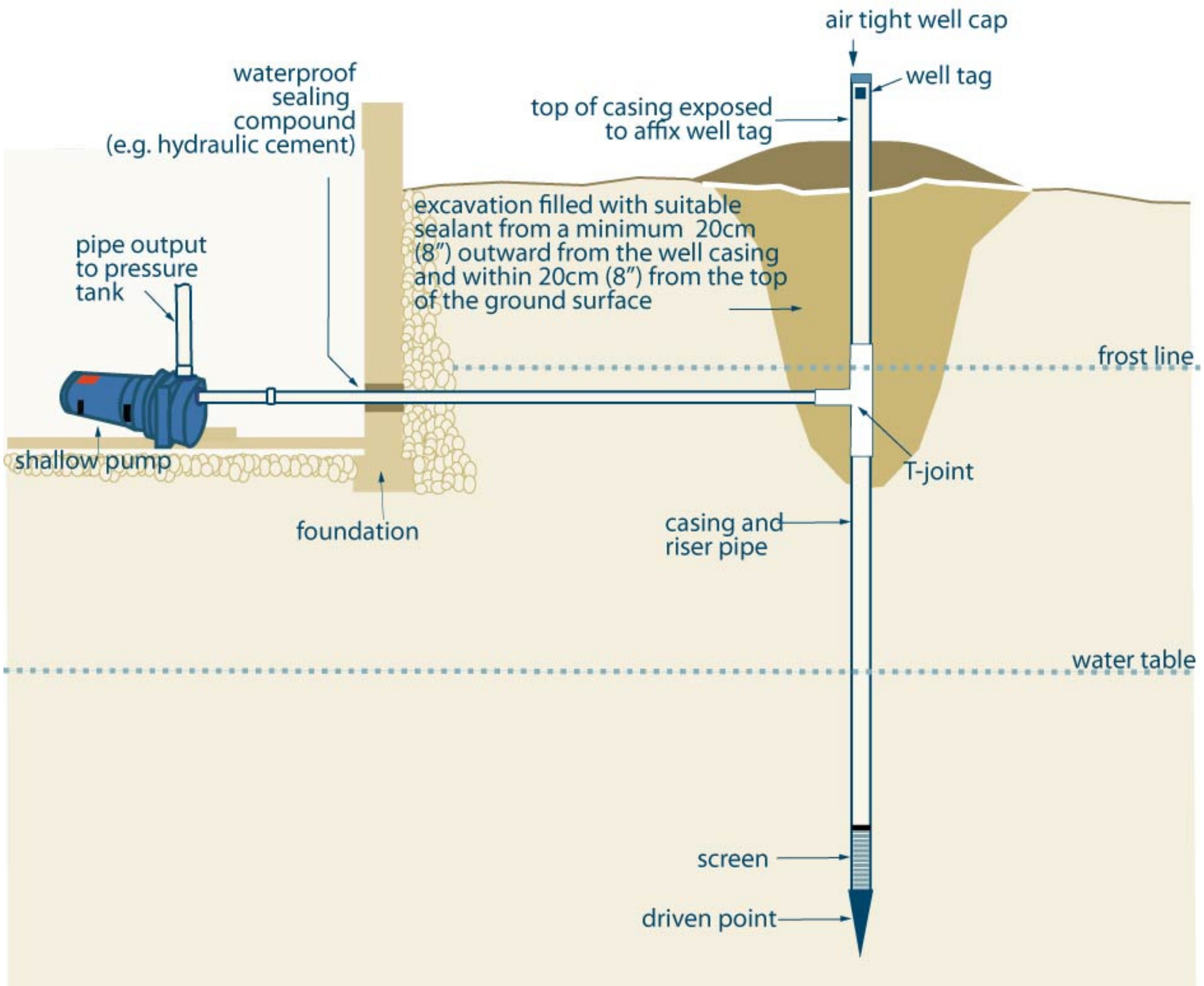


Figure 9-8 is for illustrative purposes. It does not depict every circumstance and it is not to scale.

Larger Diameter wells must not be entered as they are dangerous unless adequate safety precautions are taken using Confined Spaces Regulation 632/05 under the *Occupational Health and Safety Act*.

The pipe shown would be supported by using a pitless adapter and supporting steel bracket anchored to the inside of the casing.

FIGURE 9-9: DRIVEN POINT WELL WITH SHALLOW LIFT PUMP



Conditions and considerations for using a shallow well lift pump in a driven point well are as follows:

- Because of the small diameter of the well, this is generally the only type of pump that is suitable but a jet pump may also work.
- For new point wells constructed after December 31, 2007, a T-connection is made below the ground surface with the waterline (lateral pipe) attaching to the well casing.
- The new point well also will have an air tight well cap.
- The entire assembly must be airtight in order for the pump to maintain a vacuum in the entire well and waterline.
- The T-configuration allows access to the well and, if necessary, allows access to conduct maintenance on the well such as shock chlorination.
- The design of the point well should be able to withstand freezing and thawing.

Figure 9-9 is for illustrative purposes. It does not depict every circumstance and it is not to scale.

This set up is similar for jetted wells attached to a shallow well pump.

Connections to Wells

Drilled Wells

Below ground connections to the casing of a drilled well must be made with a well seal or pitless adapter (including pitless units) and the connection must be watertight.

Pitless units or pitless adapters allow lateral pipes (i.e. waterlines) outside a drilled well casing to connect to drop pipes (waterlines) inside the well.

A drop pipe usually extends from the connection at the pitless adapter to the pump or intake portion of the pumping equipment inside the well.

Pitless Adapters

Pitless adapters are primarily designed to make a watertight sanitary seal to the casing below frost level through the casing wall. Pitless adapters:

- Connect downhole pumping equipment to piping in the trench, and
- Allow the downhole pumping equipment to be easily removed while standing at the ground surface.

The size and number of holes through the casing depends on the design of the pitless adapter and pump equipment.

To ensure that the connection is watertight, it is necessary that person installing the pitless adapter follow the manufacturer's specifications and ensure that the adapter being installed is appropriate for the environment and the well design (e.g. casing size).

A cutting torch must not be used to make an opening in the casing wall to accommodate a pitless adapter.

A cutting torch creates an opening that is too irregular to be made watertight.

Best Management Practice – Preparing to Install Pitless Adapter

Before installing the pitless adapter, it is important to cut the hole in the casing wall with a hole saw and to remove metal burs along the open hole's edges to ensure that the pitless adapter creates a watertight fit to the casing.

A cordless drill helps eliminate the possibility of electrocution.

FIGURE 9-10: PITLESS ADAPTER

FIGURE 9-11: PITLESS ADAPTER INSTALLED

PITLESS UNITS

A pitless unit is a commercially manufactured piece of well casing with a pitless adapter already installed through the wall of the unit. It is primarily designed to make a watertight connection on top of the well casing.

Typically, a person installing a pitless unit will cut the top of well casing below the frost level. The pitless unit is then installed onto the top of the well casing by either welding or using a special clamp device.

To ensure that the connection is watertight to the well it is important that persons installing pitless units follow manufacturer's specifications and ensure that the unit being installed is appropriate for the environment and the well design (e.g. casing size).

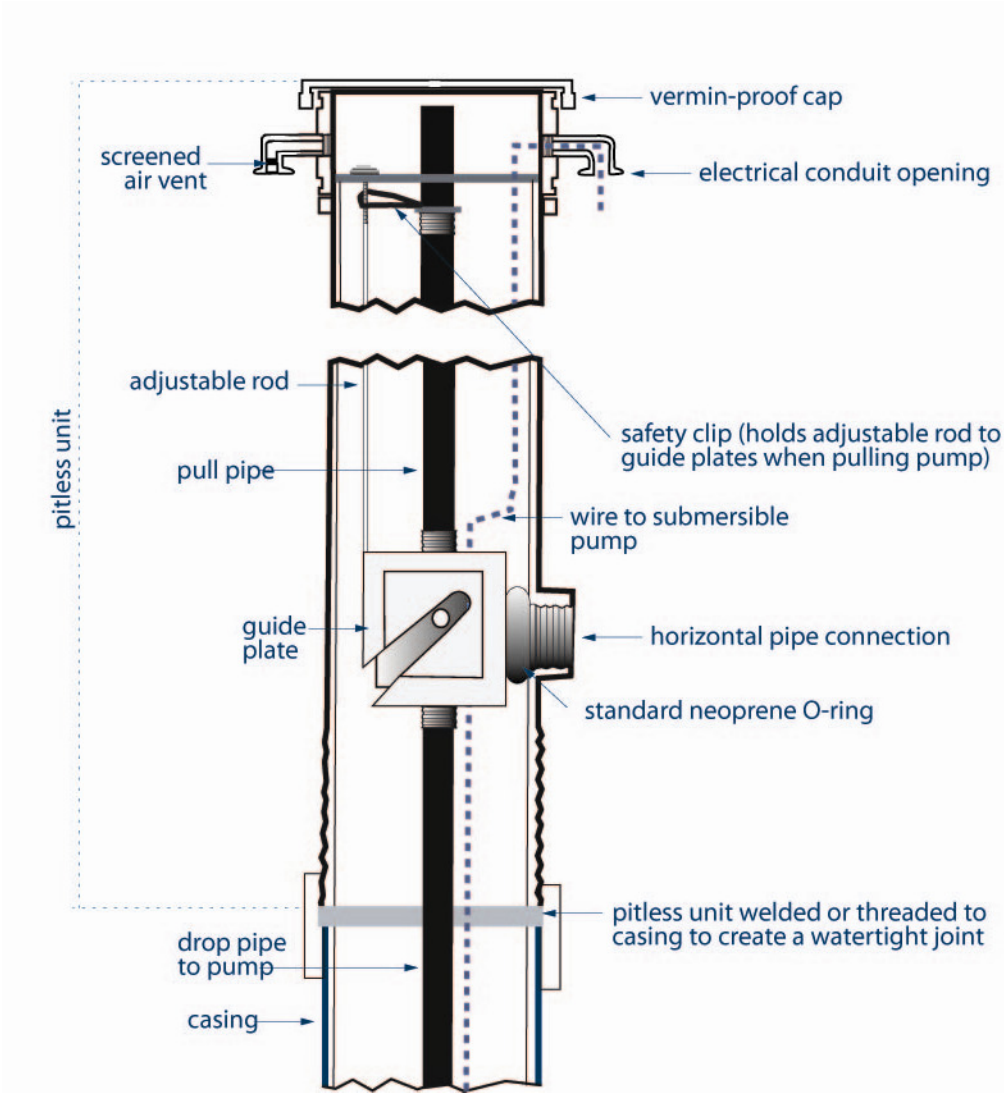


FIGURE 9-12: CROSS-SECTION OF PITLESS UNIT

FIGURE 9-13: PHOTOGRAPHS OF PITLESS UNITS

Best Management Practice – Installation of Pitless Adapters and Pitless Units

Review and follow the standards and recommendations found in the Water Systems Council brochure titled *WSC Performance Standards and Recommended Installation Procedures for Sanitary Water Well Pitless Adapters, Pitless Units, and Well Caps*[3], to assist in the proper installation of pitless units or pitless adapters.

The brochure is available through the following URL: http://www.watersystemscouncil.org/

[3] WSC PAS-97(04) – "*WSC Performance Standards And Recommended Installation Procedures for Sanitary Water Well Pitless Adapters, Pitless Units, and Well Caps*," Water System Council, Washington DC. http://www.watersystemscouncil.org/VAiWebDocs/standards_docs/PAS97_Brochure.pdf

Sanitary Well Seals

Sanitary well seals are primarily designed to create a watertight seal where the waterlines, air vents and electrical lines extend through the top of the well casing.

A sanitary well seal consists of a neoprene gasket between two steel plates. When the two plates are tightened together the neoprene gasket expands which seals waterlines, electrical lines and the casing.

To ensure that the connection is watertight to the well, it is necessary that a person installing a sanitary well seal follow the manufacturer's specifications and ensure that the seal being installed is appropriate for the environment and the well design.

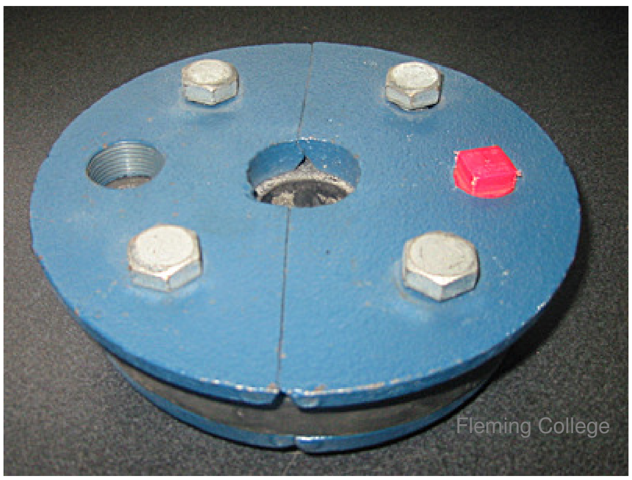


Figure 9-14: Sanitary Well Seal

The photograph shows an example of one kind of sanitary well seal. In this case, a blue coloured steel plate is underlain by a black coloured neoprene gasket. The gasket is underlain by another blue coloured steel plate. One waterline is allowed through the centre of the well seal. An air vent can be threaded onto the seal on the left side of the well seal. The red plug can be removed on the right side of the well seal to allow for an electrical line or other equipment through the well seal. By tightening the four steel bolts on top of the well seal, the two plates are tightened together expanding the neoprene gasket. The squeezed gasket seals the waterline, electrical line and the casing. The well seal is typically found at the top of the well casing. Other sanitary well seals have two holes for two waterline installations used in jet pumps.

Dug and Bored Wells

The waterline and any other connection through any well other than a drilled well (e.g. bored and dug wells) must be made watertight with a durable bonding material.

Any bonding material must be durable and adhere to the side of the casing and the waterline. Also, the bonding material must not impair the water quality.

Large diameter corrugated conduits or other pipe used to protect waterlines in trenches should not extend through the well casing. Only properly connected and sealed waterlines and electrical lines should extend through the casing.

It is important to know and follow the manufacturers' specifications for bonding material and installation of waterlines through the well casing (e.g. fiberglass, galvanized and concrete).

Best Management Practice – Waterline Connection through Concrete Casing

A concrete tile pitless adapter should be installed when a connection to a waterline is made through the side of a concrete casing.

As an alternative, a steel supporting bracket can be used on the inside of the well casing. The bracket will attach to the pitless adapter and allow the lateral pipe to extend through the casing and into the well. The horizontal pipe connection to the casing must be sealed with hydraulic cement or other durable bonding material that will not impair the water quality.

Hydraulic cement looks like other cement. It is made for use in applications to stop water leaks through cracks and faults in concrete. Tape should be used to hold the cement in the connection area while it sets (cures).

Venting The Well

The purpose of the air vent is to allow the well to breathe, which allows equalizing pressures (i.e. when water is drawn out, air goes in so the column of water remains at atmospheric pressure at all times) and the venting of natural gases.

Venting After New Well Construction

Ontario

Ensure that the well is vented to the outside atmosphere in a manner that will safely disperse all gases.

Venting During Pump Installation in Drilled Wells

Ontario

If a pump is installed in a drilled well, an air vent must be installed on the well.

An air vent must have a minimum inside diameter of:

- 0.3 cm (0.12″) for a well casing that has an inside diameter <12.7cm (5″), or
- 1.2 cm (0.47″) for a well casing that has an inside diameter ≥12.7cm (5″)

In an area where there is potential for flooding, the air vent on a drilled well must extend above the maximum anticipated flooding level and not less than 40 cm (16″) above the ground surface.

On a drilled well in a well pit, the air vent may have a sufficient length to extend above the covering of the well pit.

The open end of the air vent on a drilled well must be shielded and screened to prevent the entry of foreign materials (e.g. insects) into the well.

The vent sizes and other requirements for a drilled well do not apply to a well with a well pit if there is no potential hazard from natural gas or any other gas. However, an air vent line must be installed on the new drilled well in a new well pit and must extend above the cover of the well pit.

Best Management Practice – Venting Wells

Any well, even a well in a well pit, should be vented to disperse gases.

A well in a well pit should be vented with a shielded and screened vent (see Figure 9-30).

The largest possible vent area (cross-sectional area) should be selected to help prevent freezing during periods of extreme cold.

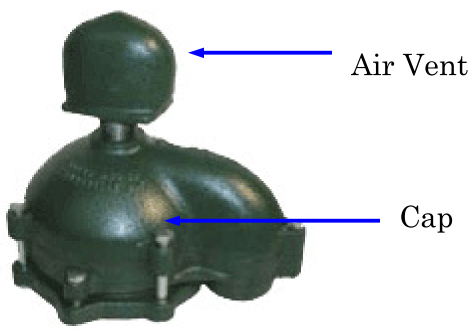


FIGURE 9-15: WATERTIGHT CAP WITH EXTENDABLE SCREENED AIR VENT LOCATED ABOVE THE WELL CAP

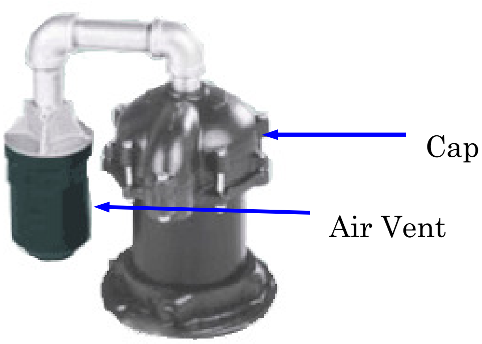


FIGURE 9-16: WATERTIGHT CAP WITH SNORKEL VENT USED TO PREVENT FLOOD WATER FROM ENTERING THE TOP OF A DRILLED WELL

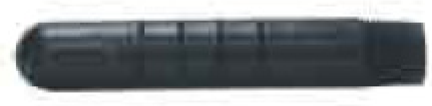


FIGURE 9-17: PVC WELL SEAL AIR VENT

This shows an example of a ½″ air vent that can be threaded on a sanitary well seal as the one shown in Figure 9-14.

FIGURE 9-18: VENTED VERMIN PROOF CAP ATTACHED TO WELL CASING.

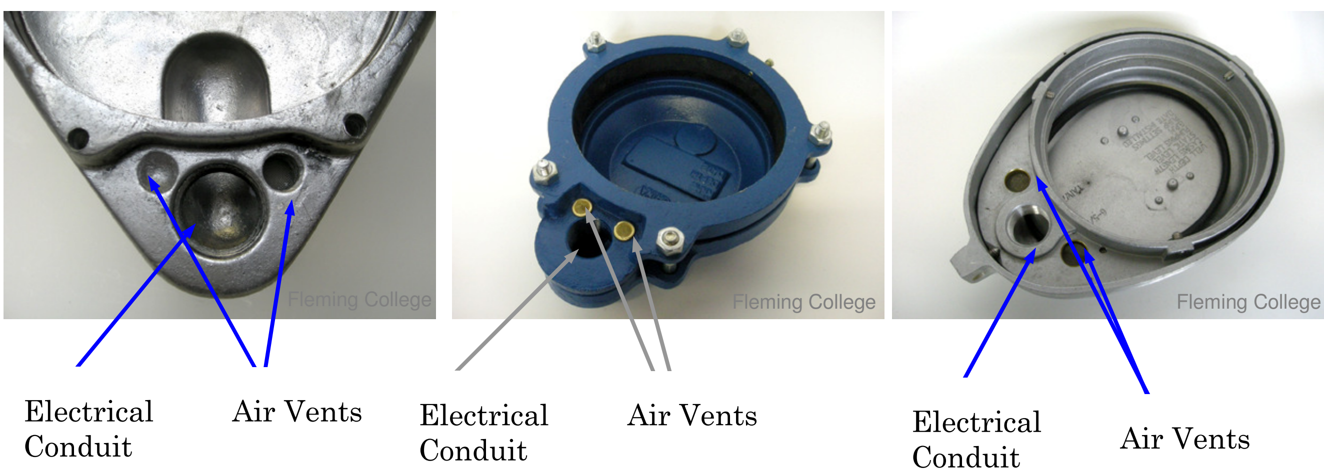


FIGURE 9-19: VENT LOCATIONS ON THE UNDERNEATH PORTION OF THREE VERMIN PROOF CAPS COMMONLY USED IN ONTARIO

Wells Encountering Gas

Where a well is constructed and natural gas is encountered, the person constructing the well must immediately notify the well purchaser, the owner of the land on which the well is situated and the Director that the condition exists.

If a well is producing a natural gas or other gas and the gas is detected, the well owner must do at least one of the following:

- Abandon the well and take the necessary steps to plug and seal the well,
- Take the necessary measures to manage the gas in a way that prevents any potential hazards and ensure the measures are functional at all times, or
- Seek the written consent from the Director to allow for the continued use of the well (see Chapter 14: *Abandonment: When to Plug & Seal Wells*).

Best Management Practice – Venting Natural Gas

If natural gas or other gas has been identified, then the person constructing the well should consider retaining the services of a *Professional Engineer* or *Professional Geoscientist* experienced in groundwater and water wells producing gas. The *Professional Engineer* or *Professional Geoscientist* should:

- assess the well and the hydrogeology and geology around the well,
- provide the well owner with written recommendations, and
- confirm that the recommendations have been implemented and the gas concerns have been abated at the site.

Well Caps and Covers

The purpose of well caps and covers is to prevent the entry of surface water and other foreign material into the well.

Ontario

At the end of well construction, wells other than those constructed by boring and digging (i.e. jetting, drilling, and driving) must be sealed with a commercially manufactured vermin-proof well cap. Solid, watertight well covers that prevent the entry of surface water and other foreign materials must be installed on a well that is constructed by boring and digging.

Preventing the entry of other materials includes designing the well cover to be of sufficient strength to withstand any known weight that might be applied to the well cover or cap and the freezing and thawing action that may cause the cover to break.

It is important that anyone constructing a well install the well cover or cap to the design specifications provided by the manufacturer and ensure that the design will work for the environment and well.

Covering the Well

Dug or Bored

The top of the well casing that is constructed by digging or boring must be covered with a solid watertight well cover so that surface water and other foreign materials can not enter into the well. This includes fastening and securing the cover to reduce the risk of children being able to access the well.

Figure 9-20: Dug Well With A Solid Well Cover

FIGURE 9-21: DUG WELL COVER WITH WATERTIGHT PLASTIC ACCESS LID ADDED TO WELL COVER

Figure 9-21 shows the green coloured access lid is sealed to the top of the concrete cover using a butyl non toxic sealing material (mastic sealing material). An opening (not shown) exists in the centre of the concrete. The top of the access lid is affixed to the access lid riser using screws. The access lid and remaining well cover must prevent the entry of surface water and foreign materials from entering the well.

Figures 9-22 to 9-25 (pages 42 to 44) are for illustrative purposes only and do not necessarily represent full compliance with other requirements found in the **Wells Regulation**.

FIGURE 9-22: WELL COVER ACCESS WITH PLASTIC LID

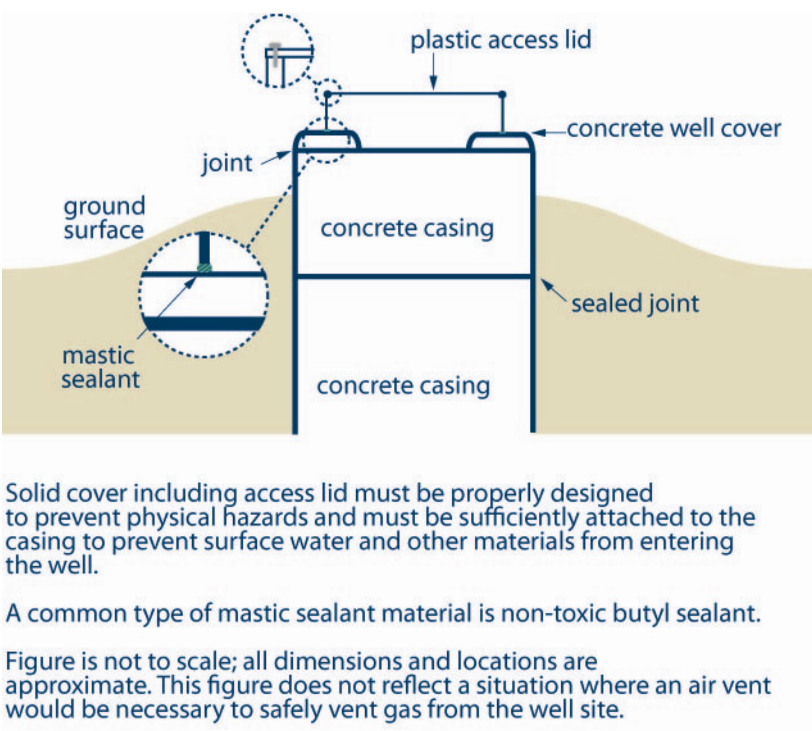


FIGURE 9-23: WELL COVER ACCESS WITH CONCRETE LID

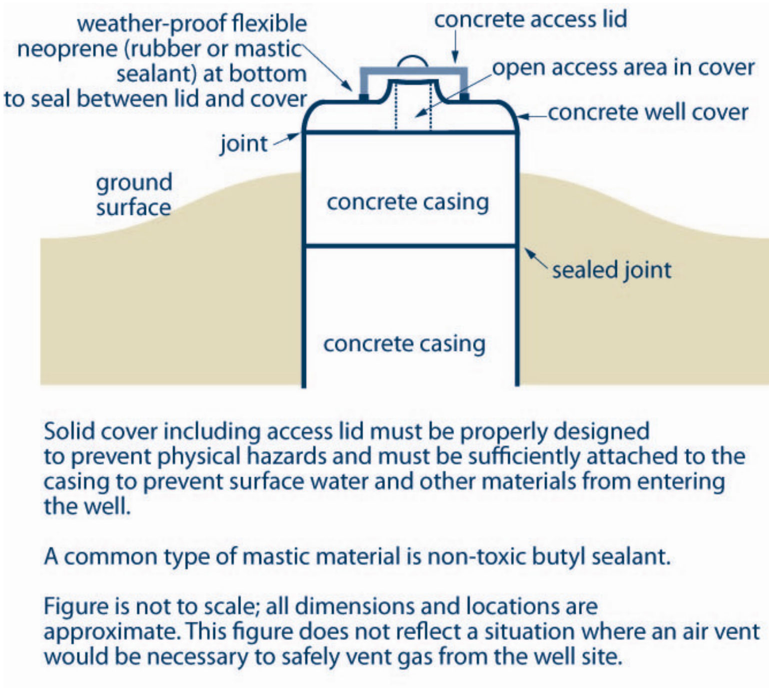
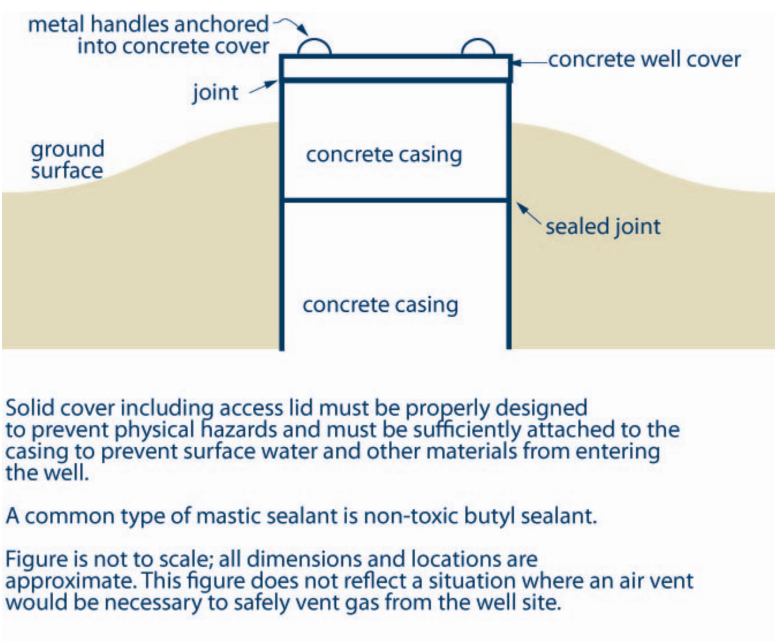
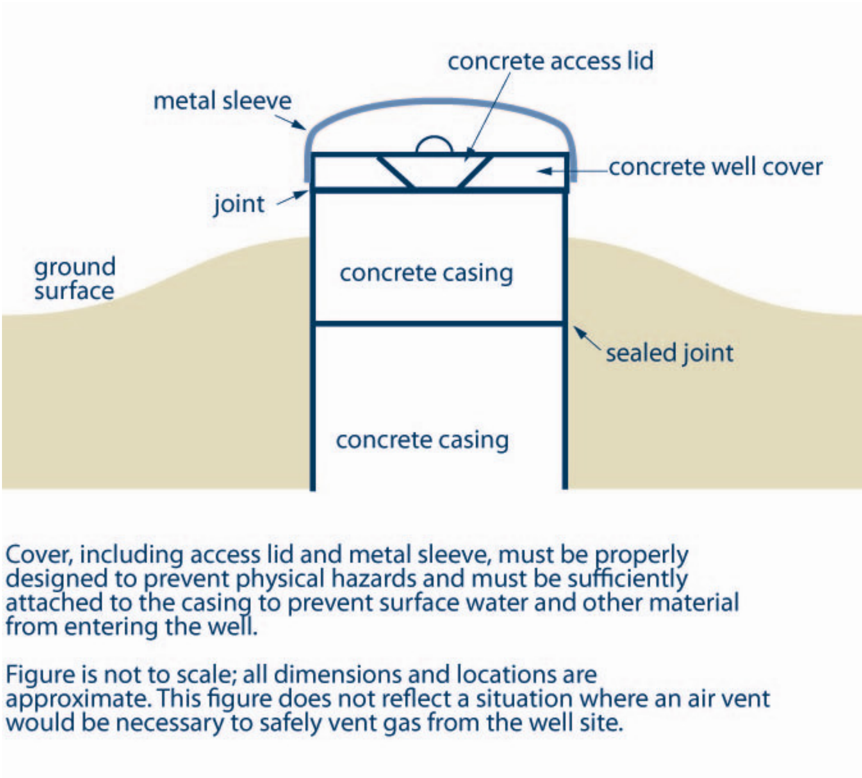


FIGURE 9-24: WELL COVER WITH NO ACCESS LID



The joint between the concrete well cover and the top casing shown in both Figure 9-23and Figure 9-24 must be sealed with a mastic sealing material strip (i.e. butyl joint non toxic sealant) in areas where flooding is anticipated to occur.

FIGURE 9-25: WELL COVER WITH METAL SLEEVE



The joint between the concrete well cover and the top casing shown in **Error! Reference source not found.** must be sealed with a mastic sealing material strip (i.e. butyl joint non toxic sealant) in areas where flooding is anticipated to occur.

DRILLED OR OTHER

The top of the well casing, that is not constructed by digging or boring, must be sealed with a commercially manufactured vermin-proof well cap (this includes a properly installed and sealed sanitary well seal, and a watertight and airtight well cap for a jetted or driven point well).

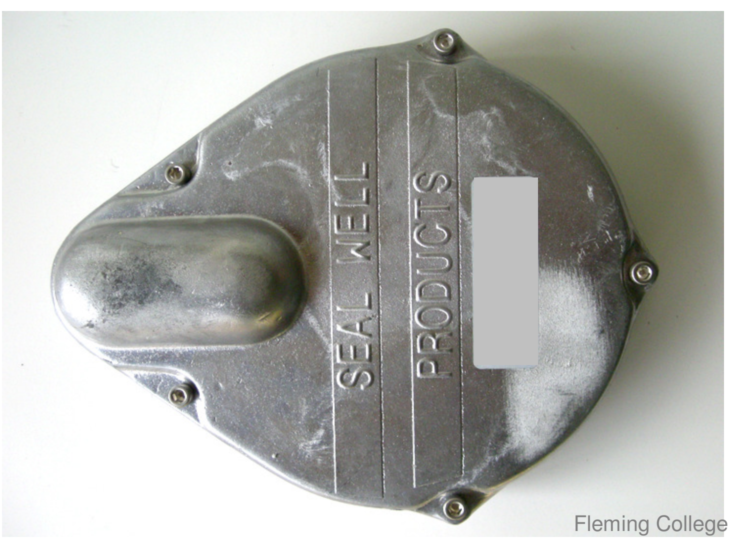


FIGURE 9-26: VERMIN PROOF WELL CAP

FIGURE 9-27: VERMIN-PROOF CAP AND THREADED CONDUIT

EXCEPTIONS TO WELL CAP OR COVER REQUIREMENTS:

Ontario

The cover, cap or seal is not required if *all* of the following criteria are met:

- A floor has been constructed around or adjacent to the casing of the well,
- A pump (which includes associated equipment such as waterlines) is installed above or adjacent to the well. This scenario would include wells with a vertical turbine pump, hand pump or other type of pump positioned directly over the casing,
- The top of the casing is shielded in a manner sufficient to prevent entry of any material that may impair the quality of the water in the well, and
- The casing of the well is extended to at least 15 cm (6″) above the floor that has been constructed around or adjacent to the casing of the well.

FIGURE 9-28: EXAMPLE OF A WELL NOT REQUIRING A COVER, CAP OR SEAL - VERTICAL TURBINE PUMP INSTALLED DIRECTLY OVER THE WELL CASING

Installing Suitable Sealant Into Trench

To install a waterline and electrical wire from the well to the building's plumbing and electrical box, a trench is typically excavated from the well to the building. The trench will expose the side of the well. The depth of the trench is typically below the frost line to minimize the risk that the horizontal waterline from the well to the building's plumbing will freeze.

When making a below ground connection to the casing of a well, any outside excavation must be filled with suitable sealant extending from the casing a minimum distance outward of 20cm (8″) and extending from the bottom of the excavation to within 20cm (8″) of the ground surface.

Best Management Practice – Sealing the Excavation

It is important to consider the direction of the trench and the proximity to potential sources of contamination as the trench can act as a pathway for contaminants to migrate to the well site or building.

If suitable sealant has been installed to a horizontal distance that is greater than 20cm (8″) from the well casing (during the filling of the well's annular space), then backfill the trench from the well casing with suitable sealant to at least the same distance as the original placement of sealant.

When backfilling the remainder of the trench, it is important to do the following:

- To help minimize horizontal movement of water and contaminants in the trench, place fully hydrated bentonite berms at set intervals at the bottom of the trench and over the top of the waterlines and electrical wires
- Backfill the trench with clean soil that can withstand the weight of persons, animals and vehicles and will not promote the movement of water

If a larger diameter pipe is used to house the waterline and electrical wires from the well to the building the person installing the pump should:

- Stop the larger diameter pipe before the outside of the building and before the trench's sealant at the well to prevent surface water and foreign materials from entering the well site or building,
- Ensure the larger diameter pipe is not perforated and is strong enough to withstand corrosion and the weight of the overlying materials, and
- Take adequate precautions to prevent water or foreign material from entering the larger diameter pipe and from being directed toward any building, foundation or the well.

Casing Height and Mounding

Any person constructing a well must ensure that the surface drainage is such that water will not collect or pond in the vicinity of the well.

The casing height must be at least 40 cm (16″) above the highest point within a 3 m (10′) radius of the outside of the well's casing for any new well after the land is properly mounded for surface drainage as measured on completion of the well's structural stage.

Figure 9-29 illustrates these measurements. By this time the well cap should already be on the well.

There are exemptions to the above well casing height requirement for a new well constructed by the use of a driven point or jetted point or with a well pit. For further information, see the section titled: "Casing Height for New Point Wells Constructed by Driving or Jetting" in Chapter 7: *Completing the Well's Structure*, and the section titled "Well Pit Floor" on page 51 of this chapter.

For any well having a casing height that extends > 40 cm above the land surface, a person must not reduce the height to < 40 cm.

For an existing well having the top of the casing extending above the land surface by < 40 cm a person must not reduce the original casing height.

The requirements for casing height for new wells are provided in Chapter 7: *Completing the Well's Structure* "Plainly Stated" section and the requirements for not reducing a casing above the ground surface are provided in Chapter 11: *Maintenance & Repair*, "Plainly Stated" section

Best Management Practice – Mounding and Height of Casing

In addition to the casing height and venting requirements, the top of the casing should extend above the known height of any anticipated flood level. Also, it is important to consider the final grade of the land surface around the well to direct surface water runoff away from the well.

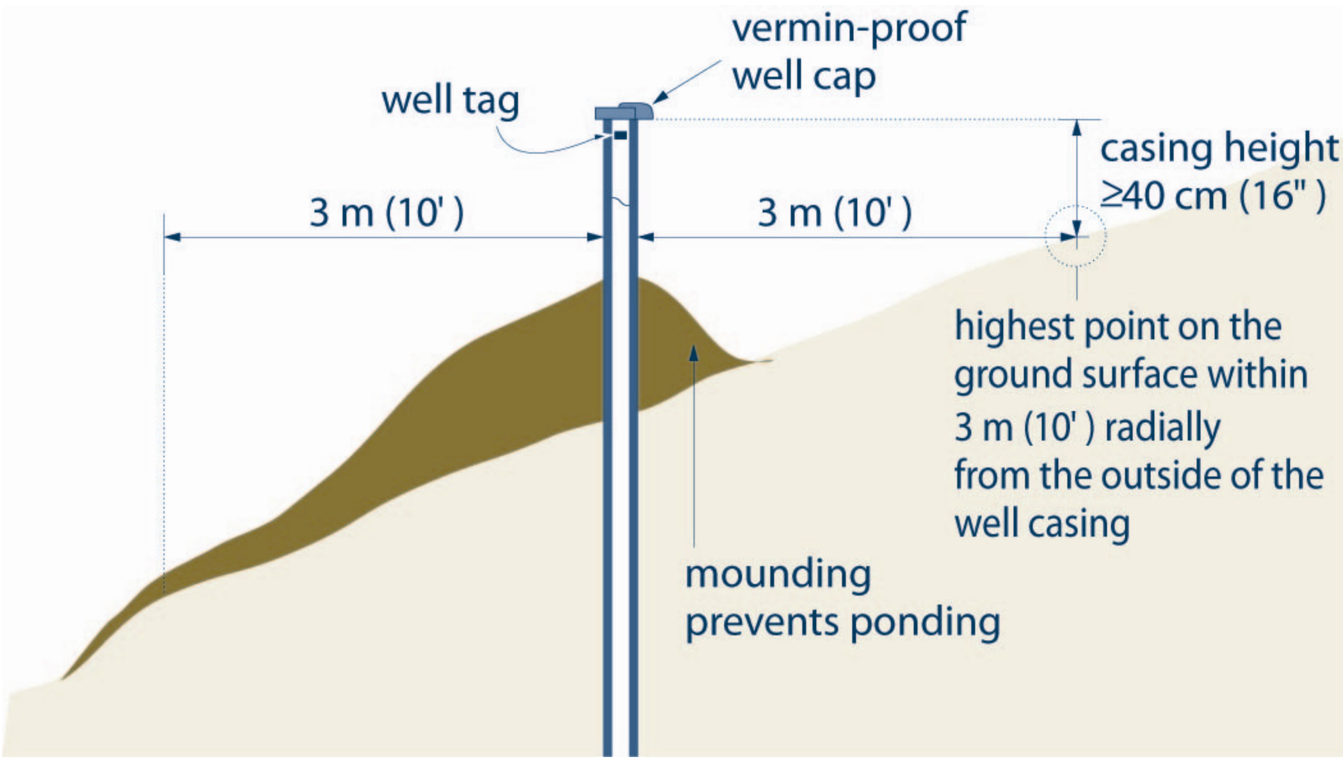


FIGURE 9-29: HOW TO MEASURE CASING HEIGHT ABOVE THE GROUND SURFACE FOR NEW WELLS (OTHER THAN WELLS CONSTRUCTED BY A JETTED POINT AND OR DRIVEN POINT AND THAT HAVE A PERMANENT VISIBLE MARKER IDENTIFYING THE WELL)

The same method of measuring casing height applies to new jetted and driven wells that have been constructed with a permanent visible marker. In that case, the casing must extend a sufficient height to permit the attachment of the well tag and be at least as high as the highest point on the ground surface within 3 m (10′) radially from the outside of the well's casing (see Chapter 7: *Completing the Well's Structure*, "Casing Height for New Wells Constructed by Driving or Jetting" section for further information).

Because of the slope shown in Figure 9-29, the casing height is more than 40cm (16″) above the ground surface immediately around the well casing.

Figure 9-29 is for illustrative purposes only. It does not depict every circumstance and it is not to scale.

All figures and diagrams are for illustrative purposes only and do not necessarily represent full compliance with other requirements found in the **Wells Regulation**.

Well Pits

Well pits are usually installed at or near the time of pump and associated equipment installation in the well. The top of the well casing extends out of the floor of the well pit.

A well pit is designed to contain the upper portion of a drilled well, prevent the upper portion of the well and waterlines from freezing and allow access to the top of the well. Well pits were the preferred choice of pump installers when installing waterlines out of the top of a drilled well to a building until the widespread use of submersible pumps, pitless adapters and pitless units began.

There are many problems with well pits in Ontario, such as:

- allowing surface water to pond around the casing and above the top of drilled wells,
- having large openings in the well pit's walls that allow surface water and other foreign materials to enter the pit and possibly the top of the well impairing the well water, and
- being structurally unsafe.

As such, well pits for water supply wells are not allowed to be installed on any new or existing well in Ontario except where a well is created using diamond drilling equipment in connection with mineral exploration.

A well pit is considered a confined space. There are a number of serious risks and hazards associated with this type of confined space. Such hazards and risks in all new and existing well pits include electrocution, asphyxiation, physical hazards such as drowning or falling, and the presence of poisonous and/or explosive gases. All required preventative measures must be undertaken prior to accessing or entering any well pit. Further requirements are found in Ontario Regulation 632/05 (Confined Spaces) made under the *Occupational Health and Safety Act*, R.S.O., CO 1.

Walls (or Casing)

The casing installed to support the sides of a new well pit must meet the casing requirements found in Chapter 5: *Constructing and Casing the Well*, and Chapter 7: *Completing the Well's Structure*. For example, if well pit casing is made of a concrete material, it must:

- be new, commercially manufactured and fully cured,
- have properly aligned and plumb casing sections,
- be clean and free of contamination,
- be watertight,
- have the joints between casing sections sealed with a mastic (e.g. butyl) sealing material approved by the NSF International that remains pliable and waterproof, and
- be at least 40 cm (18″) above the highest point on the ground surface within 3 m (10′) radially from the outside of the well pit's casing.

Surface Drainage

Surface drainage must not collect or pond in the vicinity of a new well pit's casing.

Creating and Filling the Well Pit's Annular Space

The excavation created for a new well pit must be at least 7.6 cm (3″) greater than the outside diameter of the well pit casing. A larger excavation will create a larger annular space around the well pit casing. The well pit's annular space should be filled with suitable sealant that will provide the appropriate structural strength to support the weight of persons, animals and vehicles that may move over the suitable sealant which has filled the well pit's annular space.

Well Pit Floor

The floor of the new well pit must be covered with at least a 10 cm (4″) thick layer of suitable sealant that will be capable of supporting the weight of a person. The top of the well casing must be at least 40 cm (16″) above the floor of the well pit.

It is important that the suitable sealant be able to withstand the pumping of any water from the floor of the well pit. Some sealants, such as bentonite, may erode during pumping of water from the well pit's sump (see below).

Keeping the Well Pit Dry

Sump Pump

In most situations, the new well pit must be kept dry by means of a sump pump. This could also mean a sump hole would need to be installed into the floor of the well pit. It is important that the suitable sealant be able to withstand the pumping of any water from the well pit. For example, properly cured concrete will not be removed during the pumping of water with a sump pump in any well pit sump hole.

Drainage Pipe

If the water table is substantially lower than the floor of the well pit, the new well pit may be kept dry by means of a drainage pipe using gravity drainage that extends from the floor of the well pit to a discharge location. The drainage pipe must be constructed with a one way valve from the pit to the drainage discharge area. The drainage pipe must pass through the suitable sealant layer on the floor of the well pit.

Well Cover/Seal

Ontario

The top of the drilled well casing and waterlines extending out of the well in a new well pit must be sealed with a commercially manufactured sanitary well seal to prevent the entry of surface water and other foreign materials.

Well Pit Cover

The cover of the new well pit must be:

- a solid watertight cover sufficient to prevent the entry of surface water and other foreign materials into the well pit, and
- fastened and secured to reduce the risk of children being able to access the well pit.

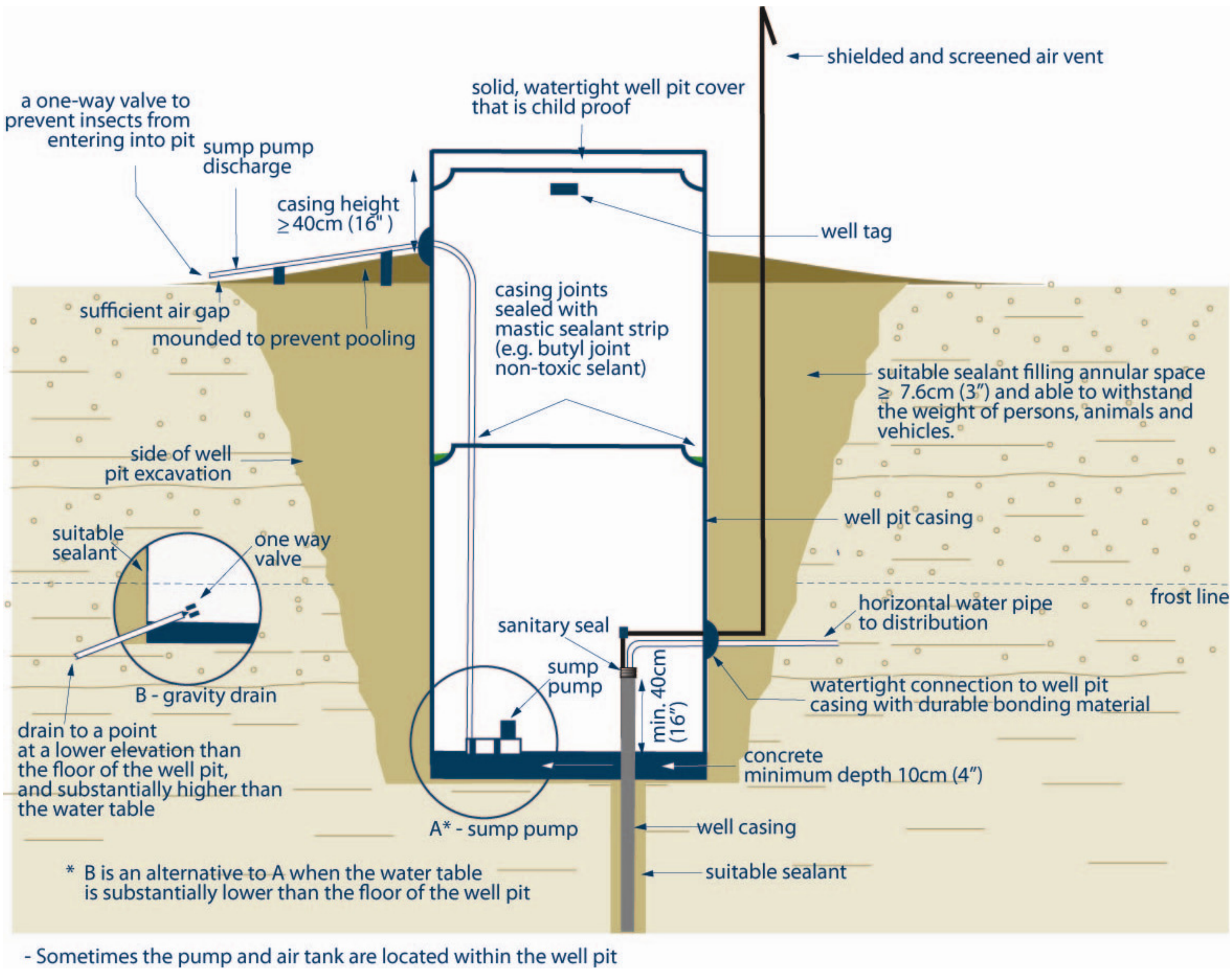
Venting the Well Through the Well Pit

Ontario

The top of the casing of the well must be provided with a length of air vent line sufficient to extend above the covering of the well pit.

To meet this requirement, the vent line may extend through the side of the well pit casing. It is important that the vent be shielded and screened to prevent the entry of surface water and other foreign materials.

Figure 9-30: An Example of a Well Pit with Sump Pump and Gravity Drain Drainage



Larger diameter well pits must not be entered as they are a safety hazard. Well pits must only be entered when adequate safety precautions are followed based on the Confined Spaces Regulation, Ontario Regulation 632/05 as amended under the *Occupational Health and Safety Act.*

Figure 9-30 is for illustrative purposes. It does not depict every circumstance and it is not to scale

Tools

Tables 9-4 and 9-5 provide information on drop pipes (waterlines) and other equipment installed in a well.

Ontario Any equipment installed in the well must be clean.

Table 9-4: Drop Pipe Comparison

These drop pipes are all approved by NSF International for potable water.

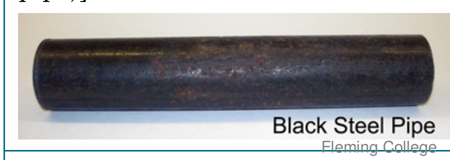
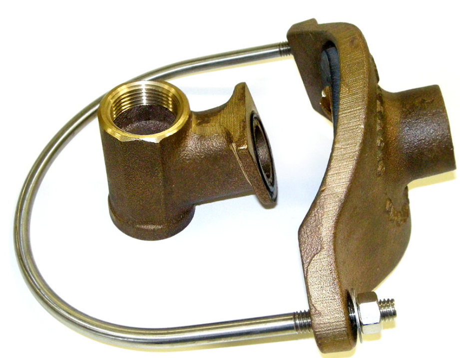
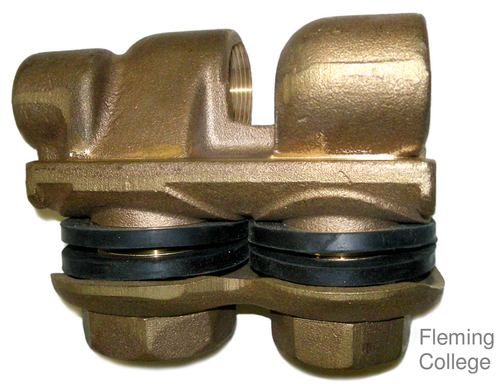
Pipe Type & Description	Diameter Range	Length Availability	Pressure Rating	Application
Galvanized Steel Pipe & Black Steel Pipe Black Pipe [steel pipe in which the outer diameter has been lacquered (as opposed to bare or galvanized pipe)].  	2.5 cm (1″) t to 20 cm (8″)	6.4 m (21′), and 3 m (10′) lengths threaded together	438 – 13,110 kPa (700 – 1,900 psi)	• Superior strength • Associated with deep wells • Is heavy and requires pump truck • Can react adversely with certain water chemistry. (e.g. low pH)
PVC Pipe – Medium and High Density  	3.2 mm (⅛″) to 61 cm (24″)	30 m(100′), 60 m (200′), and 457 m (1,500′) lengths	828 -8,487 kPa (120 – 1,230 psi)	• Can be handled without pump truck or similar equipment • Is not reactive to most water chemistry • Medium density PVC pipe is more easily handled in cold weather than high density PVC pipe
Polyethylene Pipe  	1.9 cm (¾″) – 20 cm (8″)	**Straight pipe:** 12 m (40′), 15 m 50′), 18m (60′), 30 m (100′), 90m (300′), 300 m (1,000′), and 450m (1,500′) lengths, **On Reel:** up to 3,000m (9850′) lengths	Up to 20,010 kPa (2,900 psi)	• Is not reactive to most water chemistry • Can be glued, threaded or heat fused • Tough but flexible • Softer than metal and may be damaged by abrasion

Table 9-5: Typical Equipment Installed in Wells

Always follow Manufacturer's recommendations and guidelines with any piece of equipment.

Any equipment installed in the well must be clean.

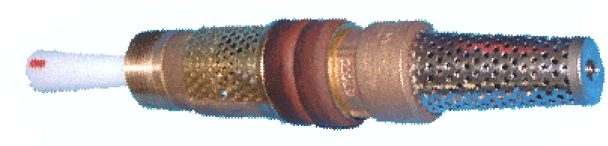
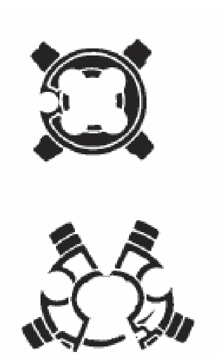
Component	Description	Graphic
Single Pitless Adapter	• 2.5 cm (1″) Single pitless adapters are the most widely used connection for domestic submersible pumps in drilled wells • 3.2 cm (1 ¼″) used for shallow well jet pumps • Available in brass and stainless steel	 Fleming College
Weld On Pitless Adapter	• Strong and durable • Typically used for larger diameter wells and municipal wells • Available in steel only	 Fleming College
Clearway Pitless Adapter	• Enables work on the well such as deepening or rehabilitating (i.e. bio-foul on a municipal well – enables a well contractor to put full gauged tools down the casing) • Also allows for a 10 cm (3 ⅝″) pump in a 10 cm (4″) casing. Customer does not need to purchase a special pump (money savings) • Available in brass and stainless steel	 Fleming College

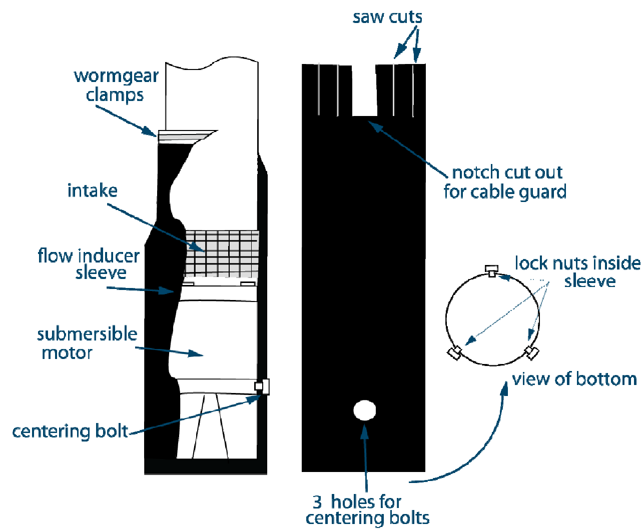
Component	Description	Graphic
Clamp On Pitless Adapter	• The durable cast steel pitless adapter housing is clamped on the outside of the casing • The water contacts only stainless steel and brass, which eliminates corrosion • When the brass tee insert is pulled, there is no obstruction left in the well and the inside diameter of the casing is completely open - can be used with steel and PVC casing as small as 10 cm (4″) in size	
Double Pipe Pitless Adapter	• Similar to a single pipe, but provides a two- pipe connection for the waterlines of a jet pump • Available in brass and stainless steel	
Cement/ Concrete Tile Pitless Adapter	• Used on cement/concrete tile • Has an extended shank to allow the pitless slide to be installed through a cement casing • Available in brass	
Corrugated Pitless Adapter	• Used for galvanized or fiberglass casings • Available in brass only	

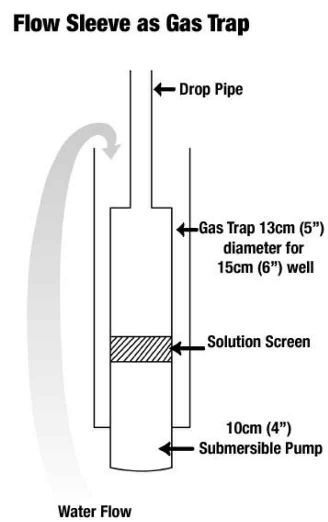
Component	Description	Graphic
Wire	• Used for running submersible pumps in wells • Stranded wire – woven • Lay flat –side by side	  
Link Seal	• Used to seal an electrical conduit or horizontal pipe that extends through a well casing. Typically used where an electrical conduit passes through the well casing of a large diameter dug or bored well • Forms a hydrostatic seal up to 275.8 kPa (40 psi)and up to 12.2 m (40′) of head pressure • Electrically isolates the inner carrier pipe from the penetrated structure	
Flow Control	• Available in various US gallon per minute ratings • Can be installed on pump discharges to prevent over pumping of the well • Make sure pressure on a pump side of the Dole Flow Valve should not exceed 827.4 kPa (120 psi)	 

Component	Description	Graphic
Foot Valves	• Function is to keep jet pumps or piston pumps primed • Can be stainless steel, brass or plastic	
Check Valves	• A check valve is used to prevent water from the system from running back into the well when the pump isn't running • Used with submersible pump to minimize pressure surges on the drop pipe (e.g. For a well that is 91m (300′) deep, one check valve is placed at the pump, another at the pressure tank and a final valve is placed at 45.5m (150′) below the ground surface in the drop pipe)	
Air Tight Cap	• A smaller cap is required for driven point wells and jetted wells due to their small diameter • Typically threaded onto the top of the casing	

Component	Description	Graphic
Solid, Watertight Well Cover	• Prevents the entry of foreign material into the well • Typically used for dug or bored wells • There are other types of solid, watertight well covers not shown in this table (see "Well Caps and Covers" section in this chapter)	
Suspension Bracket (rope hanger)	• Used to attach a safety cable to the pump • Fits on top of a drilled well casing and is easily covered by a vermin-proof well cap	
Lightening Arrestor	• Usually built into the pump • Separate component for pumps used in high capacity wells (e.g. municipal wells)	

Component	Description	Graphic
Deep Well Ejector	• Part of deep well jet pump assembly • Used in conjunction with deep well jet pump	 Two Pipe Deep Well Ejector  Single Pipe Deep Well Ejector
Cable Guards/ Cable Ties	• To protect the wire, use cable guards and cable ties	 
Torque Arrestors	• Usually located directly above the pump • Function is to prevent pump damage by stopping the pump from turning in the well, moving in the well, or banging into the side of well	

Component	Description	Graphic
Flow Inducer Sleeve	• A physical sleeve attached to a submersible pump assembly designed to channel water over the pump motor before it enters the pump intake • This provides the pump motor with a consistent supply of fresh water for cooling	
Clamps	• Used to join poly pipe to insert fittings • Make sure they are all stainless steel with stainless steel screws	
Splice Kit	• For attaching electrical wire to a submersible pump and connecting wires at wellhead • Must be waterproof and CSA approved	

Component	Description	Graphic
Insert Adapter	• Threaded at one end • Barb fitting opposite end • Joins pipe to pipe thread	
Gas Trap	• A physical sleeve attached to the submersible pump to channel water into the waterline and attempts to prevent gas from entering the waterline • However, the trap will not remove compounds such as methane that have not come out of solutions	

10. Yield Test

Chapter Table of Contents

Chapter Figures

Chapter Description

This chapter discusses the reasons, procedures and methods of measuring water levels in the well and testing the well yield. The requirements under the **Wells Regulation** are introduced and discussed. It also summarizes what should be done with the discharge water from the testing process, keeping in mind potential contamination and other environmental concerns. This chapter does not cover pumping tests designed to determine aquifer performance and characteristics.

Regulatory Requirements – Yield Test

Relevant Sections – The Wells Regulation

Ontario ***Well Yield – Sections 14.9 – 14.10***

The Requirements – Plainly Stated

Ontario **The Wells Regulation requires the following when testing the yield of the well:**

When a Yield Test is Required

The yield of a well must be tested before the well's structural stage is completed

Yield Test Exemptions

Testing the well yield is not required in any of the following situations:

- Minor alteration
- Installation of a pump
- Alteration that only involves:
    - the removal of the casing above the ground surface so that the casing is flush with the ground surface (test holes and dewatering wells only, see Chapter 11: *Maintenance & Repair*, "Casing Height When Performing Work On or Near a Well" section),
    - the addition of casing above the ground surface, or
    - the addition of a well pit to a well that was created by diamond drilling equipment in connection with mineral exploration or removal of a well pit.
- Construction of test holes and dewatering wells as long as the person constructing the well measures the static water level using a clean tape, air line or electrical device.

When to Measure and Record Water Levels

When testing the well yield, the water level in the well must be measured and recorded as follows:

- Immediately before commencement of pumping,
- At 1 minute intervals or more frequently during the first five minutes of pumping,
- At 5 minute intervals or more frequently during the next 25 minutes of pumping,
- At 10 minute intervals or more frequently during the next 30 minutes of pumping,
- At 1 minute intervals or more frequently during the first five minutes after pumping stops,
- At 5 minute intervals or more frequently during the next 25 minutes after pumping stops, and
- At 10 minute intervals or more frequently during the next 30 minutes after pumping stops.

Devices to Use to Record Water Levels

When measuring the water level use a clean plastic or metal tape or an air line or clean electrical device

The above does not apply if the design of the well does not allow for the water level in the well to be measured during the yield test. However, the well must still be pumped as stated below

Measuring and Recording the Pumping Rate

Water must be pumped from the well at a steady rate, continuously for at least one hour

Record the rate of pumping during the test on the well record

If water cannot be pumped from the well continuously for one hour, no further measurements are required and the following must be recorded on the well record:

- reason pumping was discontinued,
- rate of pumping and the length of the pumping period, and
- water level measurements made.

Relevant Guidelines

Procedure D-5-5 titled Technical Guideline for Private Wells: Water Supply Assessment, by Ministry of the Environment, Last Revision, August 1996.

Relevant Sections – Additional Regulations or Legislation

Ontario Water Resources Act section 30 – Discharge of Polluting Material Prohibited (Impairment of Quality of Any Waters)

Ontario Water Resources Act section 34 – Taking of Water (Permit to Take Water)

Ontario Water Resources Act section 53 – Sewage Works Certificate of Approval

KEY CONCEPTS

IMPORTANCE OF THE YIELD TEST

The well yield test provides important information about:

- performance of the well
- some initial characteristics of the aquifer at the time that the well is tested

The yield test information is used for a variety of purposes including, but not limited to:

- determining the sustainable rate at which the well will produce water
- selecting the appropriate pump size and type
- determining if conditions have changed that may indicate problems

The yield test, as required by the **Wells Regulation**, is not for testing aquifer characteristics. For further information on aquifer characteristic testing please see: Technical Guidance Document.

For Hydrogeological Studies In Support of Category 3 Applications for Permit to Take Water Ministry of the Environment Operations Division April 2008 at http://www.ene.gov.on.ca/publications/6644e.pdf.

There is no minimum sustained rate for a residential water supply specified in the **Wells Regulation**. The yield test is a tool to inform the well owner of an estimate of the sustained rate at which the well can be pumped. For further information on residential and livestock water needs see: Best Management Practices – Water Wells[1] (pages 14 and 15).

PUMPING RATE AND MEASUREMENTS

Ontario

The following requirements must be met:

- Immediately prior to pumping, the water level must be measured and recorded
- The well must be pumped continuously and at a steady rate throughout the test, and the pumping must be sustained for at least one hour
- Pumping rates must be recorded on the well record
- Pumping water levels must be measured and recorded:
    - at 1 minute intervals or more frequently for the first 5 minutes,
    - at 5 minute intervals or more frequently for the next 25 minutes, and
    - at 10 minute intervals or more frequently for the remaining 30 minutes of the test.
- Recovery water levels must be measured and recorded at the same time intervals as outlined in the previous bullet. The recovery starts immediately after the pump has been shut off

[1] Agriculture and Agri-food Canada, Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA). 2003. *"Best Management Practices - Water Wells, Revised Edition."* 2003.

Best Management Practice – Pumping Rate and Measurements

- Installation of a dedicated and portable submersible pump and equipment used only for the purposes of conducting well yield tests (dedicated pump), will assist in conducting a steady rate (constant rate) yield test
- The pumping rate during the yield test should be similar to the intended pumping rate in order to replicate the well's probable water levels and usage
- The rate selected should take into consideration the volume of water that is in storage in the well to ensure that the test is conducted in a fashion that clearly identifies the sustainable yield of the well
- Pumping rates should be measured accurately and be recorded at least as often as water level measurements at 5 minutes of intervals
- Measure the pumping rate using a flow meter and control device such as a calibrated orifice weir
- Measure water levels with accurate meters such as an electrical device

CONDUCTING THE YIELD TEST

To be effective, a pumping test must be accurate. While there are several methods for determining approximate yield (such as the bailer method or the air lift method), only the pump method is an acceptable testing method according to the **Wells Regulation**.

Only a pump, such as a submersible, jet or shallow lift pump with appropriate control devices and valves, can be used to pump a well continuously and at a steady rate for at least one hour.

A bailer cannot be used to conduct the yield test as water is not being pumped at a continuous and steady rate.

Also using a compressor and blowing air down drill rods cannot be used to conduct the yield test. This action disturbs the water levels in the well during the test and does not produce a continuous and steady rate of pumping. In addition, the bottoms of the drill rods are typically used as the measuring point for water levels. It is impossible to accurately measure the water levels during this disturbance. It is also impossible to accurately measure the water levels after pumping has stopped using this method because the water levels will rise above the bottom of the drill rods.

A Permit to Take Water under the *Ontario Water Resources Act* is required for many types of water takings (including pumping a well for a yield test) that are greater than 50,000 L/ day (11,000 G/Day). Therefore, the person constructing the well should estimate the taking of water during the entire test before conducting the test. If the estimate shows the test will take more than 50,000 L/day, then the person constructing the well needs to obtain a Permit To Take Water from the Ministry. More information Permit to Take Water can be found at: http://www.ene.gov.on.ca/envision/water/pttw.htm.

TO CONDUCT A YIELD TEST

The person conducting the yield test will need to:

1. Consider the yield test equipment needed to pump the well. For example:
   - Size and type of pump such as:
     - Submersible
     - Jet
   - Appropriate discharge lines that are clean and that will not impair the quality of the water. The waterlines should meet potable water specifications (e.g. NSF International).
   - Flow metering and control devices:
     - Gate valve
     - Orifice or rectangular weir
     - Constant flow restrictor valve (Dole Valve)
     - Rotameter
     - Calibrated bucket or barrel
     - High capacity flow meter
     - Manometer
   - Water level measuring devices:
     - Electrical (e.g. water level meter, sonic meter, pressure transducer with datalogger)
     - Air line
     - Tape measure
2. Clean all of the equipment to be used in the well. The person should follow the sanitary practices found in "Sanitary Practices" section in Chapter 8: *Well Disinfection*, to ensure equipment is clean.
3. Set the intake in the well at a depth to make best use of available drawdown.
4. Select an appropriate location for the discharge (See "Handling Water Discharge", page 10, for further guidance).
5. Prevent any backflow of water down through the riser and discharge pipes and into the well. This is important to minimize the risk of contamination and interference with recovery water level measurements.
6. Measure and record the static water level.
7. Begin pumping at a steady rate and pump continuously for at least one hour. Pumping rates should be measured accurately and should be recorded at least as often as water level measurements after 5 minutes of pumping (see "Best Management Practice – Pumping Rate and Measurements" above).
8. Measure and record the pumping water level measurements (see "Pumping Rate and Measurements" section and "Recording Yield Test Results" section in this chapter)
9. Shut down the pump at the end of the pumping portion of the test (a minimum of 60 minutes of pumping). The exact time and water level when the pumping stops must be observed and recorded. This is time zero of the recovery portion of the test.

10. Measure and record recovery water levels for at least the next hour (see “Pumping Rate and Measurements” section and “Recording Yield Test Results” section in this chapter).

Best Management Practice – Extending the Pumping Time Past Minimum Requirement

A longer pumping test provides more information to:

- Determine the sustainable yield of the well
- Provide greater confidence that the well can sustain the desired rate

HANDLING WATER DISCHARGE

The discharge water from a yield test must not cause an adverse effect to the natural environment and should not affect the yield test. To reduce risks, the following should be considered:

- During the yield test water should be discharged a sufficient distance away from the well being pumped to minimize or eliminate recharge of this water to the aquifer during the test
- Water discharged during the yield test should not be allowed to pond or collect near the well
- It is important that the location of the discharge take potential environmental impacts such as erosion, impairment of surface water bodies and off-site flooding into consideration (see below Note)

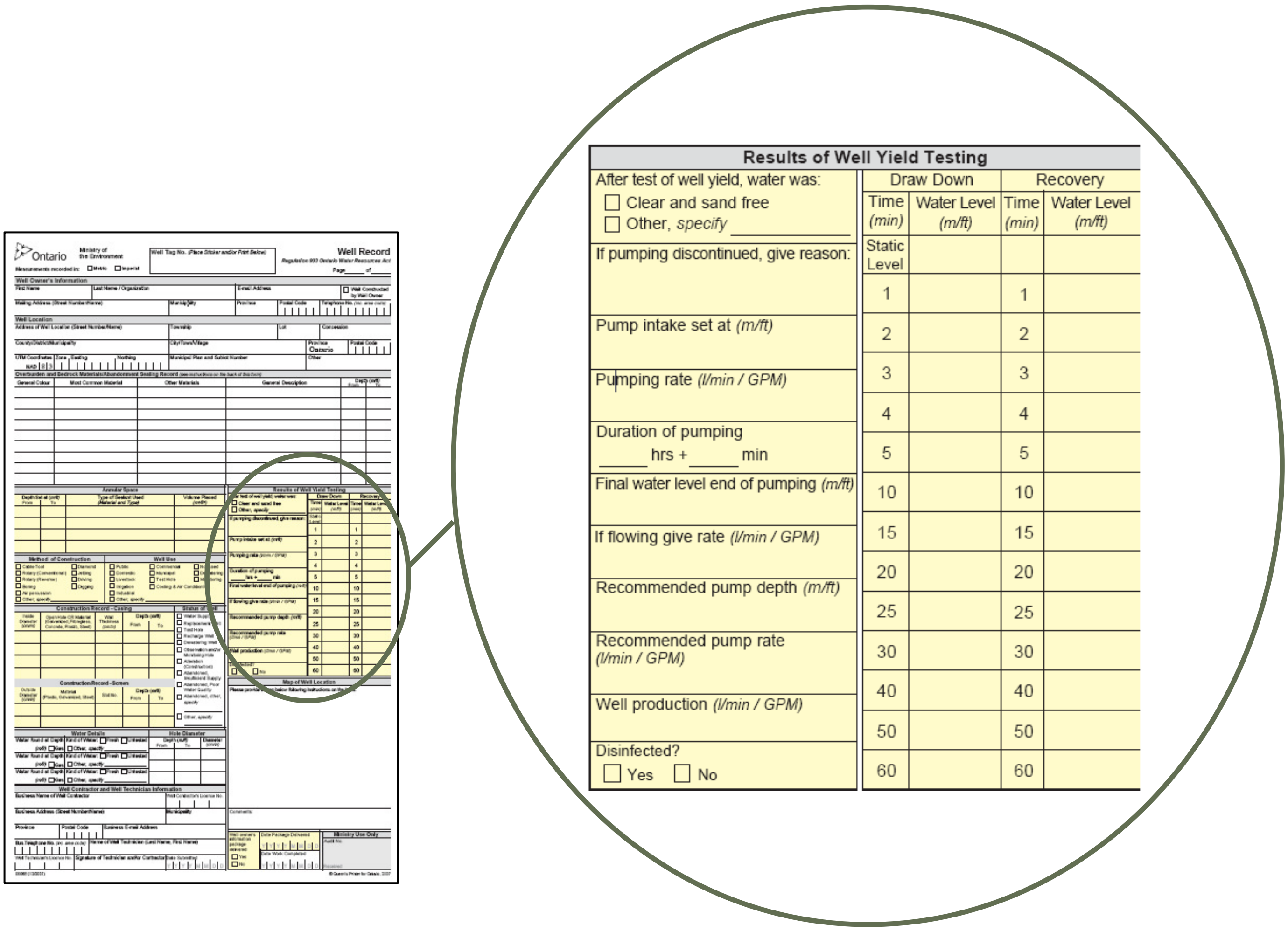
A sewage works Certificate of Approval under the *Ontario Water Resources Act* may be required if the person discharges the water from the well owner’s property and the discharge capacity exceeds 10,000 litres per day. It is important for the person to determine if a Certificate of Approval is required before discharging the well water during the testing of the well yield. A guide to explain the sewage works process can be found at the following website http://www.ene.gov.on.ca/envision/gp/4063e.htm

Recording Yield Test Results

Details Required

Figure 10-1 shows the details that are required on the well record, further details are shown in Chapter 9: *Equipment Installation* and Chapter 13: *Well Records, Documentation, Reporting & Tagging*.

Figure 10-1: Well Record – Test of Well Yield



Results of Well Yield Testing

After test of well yield, water was:
- ☐ Clear and sand free
- ☐ Other, *specify* ______

If pumping discontinued, give reason:

Pump intake set at *(m/ft)*

Pumping rate *(l/min / GPM)*

Duration of pumping
______ hrs + ______ min

Final water level end of pumping *(m/ft)*

If flowing give rate *(l/min / GPM)*

Recommended pump depth *(m/ft)*

Recommended pump rate
(l/min / GPM)

Well production *(l/min / GPM)*

Disinfected?
☐ Yes ☐ No

Draw Down		Recovery	
Time *(min)*	Water Level *(m/ft)*	Time *(min)*	Water Level *(m/ft)*
Static Level			
1		1	
2		2	
3		3	
4		4	
5		5	
10		10	
15		15	
20		20	
25		25	
30		30	
40		40	
50		50	
60		60	

Reasons for Discontinuing the Yield Test

Ontario

If water cannot be pumped from the well continuously for one hour, no further measurements are required and the following must be recorded on the well record:

- Reason pumping was discontinued
- Rate of pumping and the length of the pumping period
- Water level measurements made. This includes all recovery water level measurements made after pumping stops. Recovery water levels must be measured and recorded:
  - at 1 minute intervals, or more frequently, for the first 5 minutes after pumping stops,
  - at 5 minute intervals, or more frequently, for the next 25 minutes after pumping stops, and
  - at 10 minute intervals, or more frequently, for the remaining 30 minutes after pumping stops.

Some reasons for discontinuing the test include:

- The well running dry
- Encountering poor water quality
- Causing quantity and quality interference problems with other wells

Equipment breakdown is not an acceptable reason for discontinuing the yield test as it is expected that the test will be re-done. Use well maintained equipment and fully charged generator sets.

Best Management Practice – Re-Doing Yield Test if the Well is Pumped Dry

If the initial yield test shows the well cannot be pumped for one hour, the person constructing the well should have obtained enough information to estimate well's actual sustainable yield. To provide the well purchaser with an understanding of the well's actual sustainable rate, the person constructing the well should re-do the yield test at the lower estimated rate using the minimum requirements of the **Wells Regulation** outlined in this chapter. The information gathered from the second test can be provided on the well record in place of the initial test.

Data Accuracy

The yield test data provides important information for the person installing the pump, the well purchaser and the well owner. It is important to fill out the well record with care and as accurately as possible. The yield of a well can change significantly over time. The well record data provide necessary background information to assist in the determination and resolution of potential problems with the well. This could include water quality, quantity or operational problems.

For example:

> The original well record showed a recommended pumping rate of 45 LPM (10GPM) and the static water level of 5 m (16′). A current pumping test shows that the well is yielding 5 LPM (1.1 GPM) and the static water level of 20 m (65′). The decrease in the flow and the lower static water level suggests a problem associated with the aquifer as opposed to a problem with the pump equipment. This could be a result of nearby water taking or clogging of the well by biofilm or mineralization.

In many locations, the well records provide the only usable information on aquifer withdrawal rates. For example:

- *Professional Geoscientists* or *Professional Engineers* use the background information found on area well records to prepare for studies to evaluate area aquifers.
- In real estate transactions, the pumping test information is used to assist in determining if the well will meet the demands of the purchaser.
- A person constructing a new well can use area well records to estimate the rate of flow for a potential new well.
- Well records can assist the person constructing a well with determining the type of equipment to bring to the site.

Yield Test Terminology and Formulas

The following formulas illustrate how the data collected during the yield test can be used to determine drawdown and other characteristics to assist in determining equipment requirements as well as assist in troubleshooting.

Drawdown

When a well is being pumped, the water level in the well pumping water level (PWL) will be deeper than the static water level (SWL). The distance between the two is called drawdown as shown in Figure 10-2.

Drawdown = PWL – SWL

This difference represents the force that causes water to flow through an aquifer toward a well at the rate that water is being withdrawn from the well. The drawdown can be expected to increase as the pumping rate is increased.

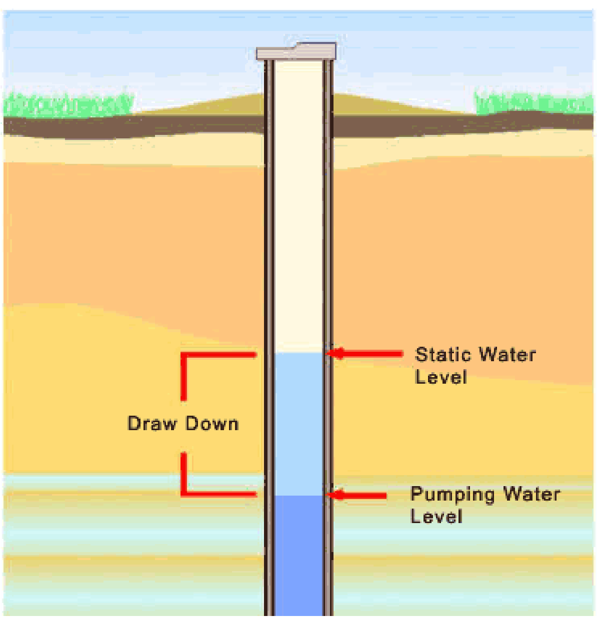


Figure 10-2: Drawdown Diagram[2]

[2] Agriculture and Agri-food Canada, Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA). 2003. Best Management Practices - Water Wells, Revised Edition, 2003.

Residual Drawdown

After pumping is stopped, the water level rises and approaches the original static water level. During water-level recovery, the distance between the recovery water level (RWL) and the initial static water level (SWL) is called residual drawdown.

Residual Drawdown = RWL – SWL

Specific Capacity

Specific capacity is the pumping rate divided by the drawdown (L/min/m or GPM/foot). The specific capacity is a measure of the drawdown caused by the pumping rate and is used as a basis for determining the well's performance. The specific capacity usually changes with both pumping rate and time.

Specific Capacity of a well = Pumping Rate/Drawdown

Example:

- The pump is located 18 m (60′) below ground surface and draws the water down to 15 m (50′). The static water level is 9 m (30′). The well is pumping at 45 L/min (10 GPM)

Drawdown = 15 m – 9 m = 6 m (50′ – 30′ = 20′)

Specific Capacity = 45L/min/6 m = 7.5 L/min/m (10 GPM/20′ = 0.5 GPM/ft)

11. Maintenance & Repair

Chapter Table of Contents

Chapter Figures

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Chapter Description

This chapter provides the **Wells Regulation**'s maintenance requirements to prevent the entry of surface water and other foreign materials from entering a well and a well owner's responsibility to meet these requirements. The chapter also provides the requirements for well owners and persons who work at the construction (or alteration) of existing wells.

To assist well owners in meeting their obligations, the chapter presents preventative maintenance programs. Common well water quality and quantity problems and well structure issues with possible rehabilitation solutions are presented for both well owners and persons who work at the construction of wells. The chapter also provides suggestions on who should assess and rectify well problems, recognizing each well and its environment are unique, and the complications involved in well rehabilitation techniques.

Regulatory Requirements - Maintenance

Relevant Sections – The Wells Regulation

Maintenance – Section 20

Abandonment – Section 21, sub-sections 21(3), 21(4), 21(5), 21(6), 21(7) and 21(9)

Protection of Well Tag – Sections 14.11 and 22

The Requirements – Plainly Stated

The Wells Regulation requires the following:

Well Maintenance

The well owner must maintain the well at all times after the completion of the well's structural stage in a way that prevents surface water and other foreign materials from entering the well.

Casing Height

For a well having a casing height that extends ≥ 40 cm (16″) above the ground surface, a person must not reduce the height to < 40 cm (16″) above the ground surface

For an existing well having the top of the casing extending above the ground surface by <40 cm (16″) a person must not reduce the original casing height

Casing Height Exemption for Driven point or Jetted Point New Wells

An exemption to the minimum casing height requirement above the ground surface exists if the well is made by the use of a jetted point or driven point and meets the following requirements:

- The well must be cased:
  - From highest point on the ground surface within a 3 m (10') radius of the well's casing after the land is properly mounded for surface drainage as measured on completion of the well's structural stage.
  - To the water producing zone, if the well obtains water from the overburden or to the bedrock if the well obtains water from the bedrock
- The top of the casing must be a sufficient height above the ground surface to permit the attachment of a well tag.
- A permanent marker must be installed to identify the location of the well and be visible at all times of the year.

Well Abandonment

The well owner must immediately abandon the well if the well is not being used or maintained for future use as a well.

The well owner must immediately abandon the well if the required measures or steps are not taken to address the following issues:

- the well produces mineralized water,
- the well produces water that is not potable,
- the well contains natural gas or other gas, or
- the well permits any movement of natural gas, contaminants or other materials.

The well owner must immediately abandon the well if the well is constructed in contravention of the **Wells Regulation** requirements and the steps taken by the well owner to rectify the situation fail.

For further information see Chapter 14: *Abandonment*: *When to Plug & Seal Wells*

Well Tags

Well tags must be safeguarded during well alterations.

In all other cases, a person must not remove a well tag from a well unless the Director has given consent to have a person remove a well tag.

No person shall deface, alter, conceal or obstruct a well tag affixed.

Any damaged well tags must be returned to the Ministry and be replaced (see Chapter 13: *Documentation, Reporting & Tagging* for further information).

See the section titled “Well Repair Requirements for Persons Constructing Wells” on page 18 this chapter for information on the requirements that apply for an “alteration” (including a repair) to a well.

Relevant Sections – Additional Regulations or Legislation

Electricity Act, 1998. S.O. 1998. Chapter 15, Schedule A; Ontario Regulations 164/99: Electrical Safety Code

Occupational Health and Safety Act, R.S.O. 1990, Chapter 0.1; Ontario Regulation 632/05: Confined Spaces

Safe Water Drinking Act, 2002. S.O. 2002, Chapter 32; Ontario Regulation 169/03, Ontario Drinking Water Quality Standards.

Relevant Guidance Documents

Fleming College. 2008. Manual for Continuing Education Course: *Safety (for Ontario Well Technicians).*

KEY CONCEPTS

Wells, like any equipment or structure, have a limited lifespan. They need preventative maintenance to keep supplying enough safe and reliable water for their users.

Ontario

The **Wells Regulation** states that the well owner must maintain the well at all times after the completion of the well's structural stage (i.e. once it is capable of being used for the purpose for which it was constructed) in a way that prevents the entry of surface water and other foreign materials into the well.

Proper maintenance, including water quality and quantity testing, is a way of ensuring that the well is kept in good working order and may minimize the need for rehabilitation. Proper well maintenance protects the aquifer and the water supply.

A poorly maintained or constructed well can result in the bacterial and/or chemical contamination of the well water, the aquifer or the natural environment. One of the most common causes of contamination is foreign materials and surface water in the immediate vicinity of a well having direct access into the well. For example, surface water and other foreign material contamination can occur if the annular seal around the outside of the casing is not watertight, if there are openings in the casing or well cover, or if casing joints are not made waterproof.

Once problems are encountered with a well, it may be possible to rehabilitate it; however, this is not always the case. Well owners should be aware that there are many instances when improper maintenance, no usage, an elevated substance identified in a water quality test or natural gas may require a well to be abandoned in accordance with the **Wells Regulation** (See Chapter 14: *Abandonment: When to Plug & Seal Wells* and Chapter 15: *Abandonment: How to Plug & Seal Wells*).

When maintaining wells, well owners must be made aware that there are many serious dangers associated with wells such as confined spaces and electrical hazards. Since most well owners are not familiar with these potential hazards, licensed well technicians working for licensed well contractors should always be hired to work on the well.

Photographs of Improper Well Maintenance

The **Wells Regulation** states that the well owner must maintain the well at all times after the completion of the well's structural stage (i.e. once it is capable of being used for the purpose for which it was constructed) in a way that prevents the entry of surface water and other foreign materials into the well.

The photographs in Figures 11-1 to 11-11 provide examples of wells not being properly maintained. In these cases, it is the well owner's legal obligation to either rectify the problem or abandon the well.

Figure 11-1: Dug Well Without Sealed Access and Improper Mounding

Figure 11-1 shows an open access lid on a dug well cover. The open lid is allowing slugs to enter the well (see Figure 11-2). The ground is not sloped away from the well to prevent ponding around the well. Even if the access lid was properly closed, surface water potentially containing pathogens and other foreign materials can still migrate through the unsealed opening (crack) between the access lid and cover and impair the well water.

Figure 11-2: Slugs Entering An Improperly Sealed Dug Well

This is the inside view of same well shown in Figure 11-1. Slugs have entered through the large opening in the well access lid and are living just below a joint between two concrete casings and just above the water level in this well. The well water is intended to be used for human consumption. The slugs are also leaving waste behind on the casing wall.

Figure 11-3: Water seeping Through The Unsealed Joints Between Concrete Casings

Figure 11-3 shows the inside view of a well. Water is seeping through the unsealed joints between concrete well casings. The water is leaving marks on the concrete tiles as it moves. The unsealed joints are allowing surface water and other foreign materials, potentially containing potential pathogens, to enter the well and impair the quality of the well water. At the bottom of the photograph, the top of the water level is observed. There is debris and other foreign material floating on top of the water that may impair the quality of the well water

FIGURE 11-4: DUG WELL CASING WITH SMALL HOLE

The centre of Figure 11-4 shows a 2 centimetre diameter hole that penetrates through the well casing of a dug well used for human consumption. The hole is located close to the ground surface. The ground surface is not properly sloped and can allow for ponding of surface water adjacent to the well. The hole provides a pathway for surface water and foreign materials such as insects, rodents and snakes to access the well and impair the well water.

FIGURE 11-5: WELL WITH WATER PONDING

Figure 11-5 shows ponded water that potentially contains pathogens located immediately beside the well. Ponded water can migrate downward through soil pores and bedrock fractures and along the side of the well casing by gravity. The ponded water can enter and impair the well water. Figure 11-5 also shows an older style non-vermin-proof well cap removed from the well and placed in the ponded water. Any pump equipment installation, repair work or other alterations would require this well cap to be replaced with a vermin-proof well cap.

FIGURE 11-6: DRILLED WELL CASING WITH HOLE IN CAP

Figure 11-6 shows a 3 cm, square hole in a well cap on top of a drilled well casing. A waterline extends out of the open hole. The open hole in the cap provides a pathway for surface water and foreign materials such as insects, rodents and snakes to access the well and impair the well water.

FIGURE 11-7: DRILLED WELL WITH OPENING BETWEEN WELL CAP AND CONDUIT

Figure 11-7 shows a drilled well with a tape measure on top of a well cap. An open hole exists between the well cap and the white coloured electrical wires and black coloured conduit (on left side of well casing). It is likely that the top of the black coloured conduit has slid down from the well cap over time to create the opening at the well cap. The opening (circled) provides a pathway for foreign materials such as insects, rodent and snakes to access the well and contaminate the well water.

FIGURE 11-8: POORLY SITED WELL THAT HAS NOT BEEN MAINTAINED

In this figure, there is a pond in the foreground. A black coloured goat is sitting on top of a well cover in the centre of the photograph. The well cover is not secured to the well casing and is not watertight. The well cover is bending downward likely due to the weight of animals lying and standing on the well cover. The well cover creates a safety hazard for the animals. Animal waste from the goats sitting on the well cover can also migrate through the well cover and impair the well water.

FIGURE 11-9: THE INSIDE OF A DUG WELL WITH A TREE ROOT PENETRATING THE CONCRETE CASING

The dug well in this figure is used for human consumption. The dug well has concrete tile as casing. Below the water level, a tree root is extending from the right side of the photograph. The tree root has penetrated the casing joint (not shown). The tree root is an indicator that the well casing is not sealed. Thus, the unsealed concrete tile joints can permit foreign materials into the well that can impair the well water quality.

FIGURE 11-10: A POORLY MAINTAINED WELL PIT

Figure 11-10 was taken looking into a well pit. The concrete tile of the well pit is shown in the centre and upper portion of the photograph. The floor of the well pit consists of gravel and broken limestone bedrock. The sanitary seal of the top of the drilled well is located flush with the floor of the well pit. Two waterlines and an air vent extend out of the drilled well's sanitary seal. There is an open hole in the well pit's concrete tile. A white to tan coloured fungus (foreign material) has been allowed to grow in the pit from the concrete hole and onto the floor. The fungus is also an indicator that surface water can enter the pit. If surface water fills up in the well pit, it could migrate through the air vent and into the well. Fungus and other foreign materials can potentially migrate from the pit into this drilled well that is used for human consumption.

FIGURE 11-11: UNSEALED CONCRETE JOINTS AND ANIMAL TIED TO WELL

The centre of Figure 11-11 shows the concrete tiles and lid of a dug well. The joint between the first and second concrete tiles is broken and not sealed. The unsealed joint creates a pathway for foreign materials to enter the well. Also a dog, tied to the top of the well cover, is shown on the right side of the photograph near a tree. There is a potential for animal waste to be discharged near or on the well. Animal waste can migrate to and impair the well water used for human consumption.

General Maintenance for Well Owners

Proper maintenance by the well owner requires ongoing observation of the state of the well, the pumping and other equipment associated with the well and the surrounding area. The owner of the land is responsible for the maintenance of every well located on the owner's property. A well maintenance checklist for a well owner and some solutions could include:

- Documentation of the well location
- Visual inspection in and around the well annually, or more frequently. A good time to inspect the well is shortly after the snow melt or a heavy rain storm. If a well record is available, compare the construction, water levels and water quality information (e.g. taste, odour, and colour) on the record when inspecting the well
- Verification that the well is not allowing the entry of surface water or foreign materials by:
    - Making sure the well cap is securely in place. Remove the well cap and look for signs of moisture, spiders, spider webs, insects and other foreign materials attached to the inside of the well cap. If the well cap or cover is damaged, cracked, or allowing foreign materials including insects to enter the well, replace with a vermin-proof cap or watertight well cover immediately
    - Ensuring the well cap or cover can withstand the weight of persons and animals
    - Looking at the air vent for cracks or holes. Make sure the air vent is not plugged and a screen is shielding the vent to prevent the entry of insects and other foreign materials into the well
    - Looking for signs of corrosion or deterioration, cracks, holes or gaps on the casing. This could include moisture or water seepage, rust (iron) stains or black (manganese) stains at or below joints, waterline inlets, holes or cracks on the inside of the well casing. All holes, cracks and joints must be sealed with a sealing material that is waterproof and approved for potable water use by NSF International
    - Looking and listening for signs of surface water seeping or cascading down into the well along the well casing or just below the well casing
    - Looking for pooling of water around the well. The ground surface needs to be appropriately sloped (mounded) to prevent surface water from pooling around the wellhead
    - Looking for the ground settling around the outside of the well casing. This could mean the annular seal is compromised allowing surface water to seep into the well
    - Ensuring any space outside the casing and around waterlines is properly sealed with a suitable sealant, such as a bentonite slurry or other material as needed. All damage to the sealant from settlement or erosion must be repaired
    - Looking for and removing any debris floating in the well. Debris floating on the surface of the well water (e.g. plant matter, insects, rodents, etc.) indicates that foreign material is entering the well through the casing, or the well cap or cover. This may mean that replacing the well cap or cover and disinfecting the well are required.

- Identification and correction of any of the following situations that might result in contamination:
  - Downspout and underground storm water pipe discharge directed toward, near or into the well
  - Refuse, manure, pesticides, fertilizers, petroleum products, salt, paint, animal waste or any other potential contaminants stored, used or disposed of near the well
  - Animals and equipment located near the well
  - Vehicles such as cars, trucks, trailers, boats, snowmobiles parked or stored near the well
  - Flowers, shrubs or trees planted around the wellhead (as the roots can compromise the annular seal protecting the well)
- Verification that the top of the well is accessible for future repair
- Identification of changes in the appearance (aesthetic) or physical quality of the water, such as turbidity, colour, taste or odour, especially after a rainstorm or snow melt
- Verification that testing of the well water is done routinely to ensure the quality is acceptable; retain the results for future reference
- Verification that the sewage system (septic tank system) works properly and has been properly maintained (e.g. pumped regularly)
- Identification of signs or abnormal sounds indicating wear on the pump, waterlines, electrical cables and associated equipment. In some cases electrical cables collect films, dirt or dust that may contain pathogens
- Verification of the pump's and the well's efficiency. If the pump is continually running or losing pressure it may be a sign of a crack or hole in the waterlines. In other cases, iron bacteria and mineral encrustation can clog pump intakes, well screens and water intake zones and reduce water yields. Changes in water quality combined with a decrease in efficiency may indicate that maintenance is required.

Where existing well pits are in use, they should be regularly inspected and must be properly maintained just like a well. Well pits are prone to collect surface water and other foreign materials. Any surface water or foreign materials that collect in a well pit can potentially access the well through the top of the well. If surface water or other foreign materials are entering a well pit, the well including the well pit must either be properly plugged and sealed or upgraded to prevent the surface water and foreign materials from entering the well.

Well owners should review the safety considerations at the end of this chapter when conducting assessments of their wells.

Testing the Water

Bacterial Testing

Routine water quality testing is an important aspect of well maintenance for a well owner. A well owner should submit a water sample at least three times each year (or more frequently if a problem is suspected) to the Public Health Unit, an Ontario Public Health laboratory (in a bottle supplied by the Ontario Agency for Health Protection and Promotion) or a private licensed laboratory for indicator bacteria (total coliform and *E. coli*) testing.

The bacterial quality of water cannot always be determined from a single sample. To establish bacterial drinking water quality, the well owner should submit 3 samples at least one week apart. Even if the well shows acceptable total coliform and *E. coli* results, it is recommended that samples be taken and analyzed at least three times a year. One of these samples should be taken in the early spring.

See "Sampling and Analyzing Well Water" section, Table 8-9 in Chapter 8: *Well Disinfection* for information on groups involved in bacterial sampling and testing.

Repeated detection of bacteria in the well water samples means that there is a source of bacteria affecting the well water (e.g. surface water, septic system, manure storage, animal exercise yards or fields where manure is spread). In cases of repeated detection of indicator organisms or other contamination, measures should be taken to identify the source and then prevent it from accessing the well. This may include hiring a licensed well technician working for a licensed well contractor*, Professional Geoscientist* or *Professional Engineer* to conduct the assessment. If the assessment concludes remediation of the well is required, it is recommended that the well owner retain a licensed well technician. The well technician that is retained, must hold the correct class of licence and work for a licensed well contractor to conduct the recommended rehabilitation of the well. A water treatment specialist may also be consulted to remove the contaminant from the drinking water, however, the problem will not be resolved if water treatment is pursued without identifying and addressing the source of contamination. If water quality interference is suspected, it is important to contact the local Ministry of the Environment district office.

For issues with water that is not potable see Chapter 14: *Abandonment: When to Plug & Seal Wells*

Considerations for Testing the Water

Groundwater quality in Ontario is generally quite good. However, as part of protecting a drinking water supply, it is important to know the well's water quality and to monitor its changes.

Water should be tested regularly for additional parameters (e.g. chemical). A well owner should:

- Test for nitrate annually and other metals and minerals at least every two years. Some common chemical parameters include sodium, chloride, conductivity, colour, turbidity, calcium, magnesium, manganese, hardness, alkalinity, pH, ammonia, nitrite, nitrate, phosphorus, fluoride, uranium, lead, antimony, arsenic, copper, iron, zinc and sulphate. Also test for some common gases such as hydrogen sulphide, methane and radon.

- If there is a reason to suspect that there may be a local problem such as nearby spills (e.g. gasoline station leak), landfills, industrial and mining activities, accidents, or land use changes, test for pesticides, volatile organic compounds (solvents), petroleum hydrocarbon parameters (benzene, toluene, ethylbenzene and xylenes), heavy metals, and radionuclides. If there is no cause for concern, a general screening of these additional organic chemicals and metals at least every five years will help verify current water quality.

If problems with well water quality are reported by neighbours or there are changes in taste or visual quality of the water, test the well water for the above bacterial and chemical parameters.

Local public utilities regularly test well water quality of municipal and other communal well supplies. If nearby municipal or communal supplies uncover elevated parameters in the municipal well water, test the well water for the problem parameter.

Use a laboratory licensed under the *Safe Drinking Water Act* to analyze the well samples for the chemical and radiological parameters. Follow the sampling and preserving procedures provided by the laboratory or retain the services of a *Professional Geoscientist* or *Professional Engineer* to conduct the sampling.

If necessary use a *Professional Geoscientist* or *Professional Engineer* to interpret the test results.

Table 8-9 of Chapter 8: *Well Disinfection* provides the various roles of different groups involved in bacterial testing and interpretation. Some of these same groups can also provide assistance with chemical testing and interpretation.

The Technical Support Document for the Ontario Drinking Water Quality Standards, Objectives and Guidelines June 2003, revised June 2006, PBIS 4449e01 http://www.ene.gov.on.ca/envision/gp/4449e01.pdf can also assist in the interpretation of the well water quality.

The resource kit "*Keeping Your Well Water Safe to Drink*" also provides general information on water quality and steps to rectify and treat the problem. The kit is available through the following website: http://www.health.gov.on.ca/english/public/pub/watersafe/watersafe_wellknow.html

Assessing the Interior of the Well with Video Technology Equipment

The lack of light and significant depth in many drilled and bored wells may result in unknown problems with the well's structure, pumping equipment, quantity or quality being hidden from view. To assist in the visual interpretation of the well, video cameras and other equipment can be installed into the interior of a well and linked to video terminals at the surface.

Down-hole video equipment can help assess:

- the well's interior structure including the casing, casing joints and well screen
- the pump and associated pumping equipment
- water levels, water producing zones and depth,
- turbidity, colour and sediment problems, and
- biofilm and mineral encrustation problems.

Best Management Practice – Use Down-hole Video Equipment in Assessment of Well Problem

As part of a well assessment for a well problem, well owners should consider retaining the services of businesses that have down-hole video equipment and who employ persons who have proper experience in installing the equipment and interpreting the video. In some cases, pumping equipment needs to be installed in the well with the video camera to lower the well's water level to inspect the well.

The video should be recorded by the person conducting the inspection and kept by the well owner for future reference and repairs.

Persons and businesses conducting this work must meet the licensing requirements in Chapter 3: *Well Construction Licences: Obtaining, Maintaining & Exemptions*.

Well repair Requirements for Persons constructing Wells

Requirements for Repairs and Alterations on Existing Wells

Requirements for the construction of new wells are found in sections 12 (location of wells), 12.4 (well depth), 13 (casing), 14, 14.1 to 14.5 (annular space), 14.8 (development) and 14.11 (tags) of the **Wells Regulation**. Except for well tagging (see Chapter 13: *Well Records, Documentation, Reporting & Tagging*), these requirements will typically not apply to persons repairing or altering existing wells. For example, new well construction requirements do not apply when a person constructing a well:

- Conducts a minor alteration on an existing well (see "Minor Alteration" in Table 2-1 in Chapter 2: *Definitions & Clarifications* and "Routine Repair" Table 2-2 in Chapter 2: *Definitions & Clarifications*)
- Replaces a pump or associated pumping equipment such as a pitless adapter or pitless unit into an existing well
- Extends a well casing above the ground surface
- Installs a new length of casing (commonly called a casing sleeve or liner) inside the well
- Removes a portion or section of well casing from the well.

Equipment used in the re-development of an existing well, such as hydrofracturing, and other equipment installed in an existing well for rehabilitation purposes is not considered to be a routine repair. As such, this activity is an "alteration" to a well that is not a "minor alteration".

If an existing well is being altered (other than a minor alteration or pump installation) some regulatory requirements do apply. After the alteration has been completed on the well, the well is again capable of being used for the purpose for which it was constructed. A person must then perform a yield test (see Chapter 10: *Yield Test*), disinfect the well (see Chapter 8: *Well Disinfection*) and complete a well record (see Chapter 13: *Well Records, Documentation, Reporting & Tagging*).

Extension of Well Casing for a Well in a Well Pit

If an alteration involves the extension of a well casing above the ground surface for a well in a well pit, the well owner will need to decide if the well pit is to be maintained or abandoned. The person constructing the well and the well owner should also consider following the "Best Management Practice – Well Casing Extensions" on page 21 for determining the appropriate height for the well casing above the ground surface.

If the well pit is to be maintained, then the person constructing (altering) the well must ensure surface drainage is such that water will not collect or pond in the vicinity of the well, including in the well pit. If the well pit cannot be maintained such that surface water and other foreign materials are prevented from entering the well, then the well pit must be abandoned.

If the well pit is to be abandoned, the person abandoning the well (often the well owner) must ensure the well pit is abandoned, with necessary modifications, as if it were a well (see Chapter 15: *Abandonment: How to Plug & Seal a Well* for further information).

Best Management Practice – Consider Abandoning Well Pits at the Time of Well Casing Extension

Where a well pit is present, a well owner should consider abandoning the well pit if the well casing is extended above the ground surface. If abandoned, the well pit must be abandoned in accordance with the requirements presented in Chapter 15: *Abandonment: How to Plug & Seal a Well*. Properly abandoning the well pit will reduce well maintenance issues and reduce the risk of surface water and foreign materials entering the well.

To determine which prescribed well technician licence class applies to the types of work being performed on an existing well see Chapter 3: *Well Construction Licences: Obtaining Maintaining & Exemptions.*

INSTALLING USED EQUIPMENT DURING WELL REPAIR

The **Wells Regulation** allows for the installation of used pumps, pumping equipment, vents, cover, caps, pitless adapters, pitless units and other equipment in wells.

All new or used equipment installed in, or connected to, a well must be clean and must not impair the quality of the well water or aquifer. Well owners must maintain installed equipment to ensure it does not impair the quality of the well water.

Best Management Practice – Ensuring Equipment is New and Chlorinated

In addition to the requirement that equipment be clean and free of contamination, it is important that anyone working on an existing well should consider:

- Installing new parts, devices and materials in drinking water wells that are certified to meet the National Sanitation Foundation (NSF) International Standard 61 "Drinking Water System Components - Health Effects". Verify the components are certified by searching NSF/ASNSI Standard 61[1] Approved Drinking Water System Components database: http://www.nsf.org/Certified/PwsComponents/ and by looking for the NFS logo on the equipment
- Installing parts, devices and materials that are suitable for the particular type of environment and well
- Cleaning the equipment with chlorinated water as suggested by *AWWA C654* standard "*Disinfection of Wells*[2] or the *Michigan's Water Well Disinfection Manual*[3] if necessary (See Chapter 8 – *Well Disinfection*)
- Ensuring parts are installed to the manufacturers' specifications

[1] NSF International Standard/American National Standard 61, 2008. "*Water Treatment and Distribution Systems - Health Effects, 27th Edition*." NSF International, Ann Arbor, MI 2008. www.nsf.org

[2] American Water Works Association (AWWA). 2003. ANSI/AWWA C 654 - 03 – "*Disinfection of Wells*." AWWA, Denver, CO. 2003. www.awwa.org

[3] Holben, Ronald J., and Gaber, Michael R.S. 2003. *Michigan Department of Environmental Quality: Water Well Disinfection Manual*. Michigan DEQ, Lansing MI. Available Online: http://www.deq.state.mt.us/wqinfo/swp/Disinfection_Manual.pdf

Casing Height When Performing Work on or Near a Well

Persons, including well owners, should be aware that for any routine well maintenance, repair or alteration, or performing any work such as landscaping around a well:

- Where a casing height extends ≥40 cm (16”) above the ground surface, the top of the casing must not be reduced to a height of <40 cm (16”) above the ground surface.
- Where the well is an existing well and the casing height extends <40 cm (16”) above the ground surface, the top of the casing must not be reduced below the original casing height.

The casing heights above do not apply to wells constructed by the use of a driven point or jetted point wells as long as they meet the minimum requirements of the **Wells Regulation**. For further information see page the section titled: “Casing Height and Mounding,” of Chapter 7: *Completing the Well’s Structure*.

The casing heights above do not apply to test holes or dewatering wells constructed as flush mounts in accordance with the **Wells Regulation**. Further information will be provided in the Test Hole and Dewatering Well: Requirements and Best Management Practices manual.

To determine which prescribed well technician licence class applies to raising the well casing height on an existing well see Chapter 3: *Well Construction Licences: Obtaining Maintaining & Exemptions*.

Best Management Practice – Well Casing Extensions

A person extending a well casing above the ground surface in an existing well should:

- consider the methods, materials and installation techniques outlined in the Best Management Practice titled “Ensuring Equipment is New and Chlorinated” on page 20 of this chapter,
- meet or exceed the new well requirements for the height of the well casing and annular space in the **Wells Regulation**,
- extend the top of the casing above the known height of any anticipated flood level, and
- consider the final grade of the ground surface around the well to direct surface water runoff away from the well.

Safeguarding the Well Tag

Ontario

Well tags must be safeguarded during well alterations.

In all other cases, a person must not remove a well tag from a well unless the Director has given consent to have a person remove a well tag.

No person shall deface, alter, conceal or obstruct a well tag affixed.

Any damaged well tags must be returned to the Ministry and be replaced (see Chapter 13: *Documentation, Reporting & Tagging* for further information).

Well Problems and Rehabilitation

Over time, the well quantity or quality may deteriorate or fail and rehabilitation of the well may be necessary. Table 11-1 (below) provides some common problems, possible causes and rehabilitation techniques associated with wells.

Table 11-1, below, contains only some examples of common causes of well problems and rehabilitation techniques and may not apply to all wells. As each well and environment is different, a *Professional Engineer* or *a Professional Geoscientist* should assess the well and well water to identify the source of the problem and provide recommendations on a case by case basis. In some cases, a licensed well technician with the correct class of licence working for a licensed well contractor can conduct the assessment of the well. If the assessment concludes remediation of the well is required, it is recommended that the well owner retain a licensed well technician. The well technician that is retained must hold the correct class of licence and work for a licensed well contractor to conduct the recommended rehabilitation of the well. It is important to retain properly licensed persons where electrical or plumbing work is necessary. Where water treatment is deemed necessary or is advised, it is recommended that a professional water treatment expert install any water treatment devices on the building's plumbing. It is important that water treatment devices are maintained in accordance with manufacturers' specifications to ensure effective operation.

Table 11-1: Examples of Common Well Problems, Possible Causes and Rehabilitation Techniques

Problem	Potential Cause	Possible Action/Rehabilitation
Foreign substances in the well (e.g. insects)	Compromised well cap, well cover, sanitary well seal or casing.	• Repair or replace defective components, and then clean and chlorinate the well (see Chapter 8: *Well Disinfection*)
Pumping equipment failure	Sediment in the well clogging pumping equipment, well screen and plumbing.	• Clean the well (extraction of sediment from the well) followed by well disinfection (see Chapter 8: *Well Disinfection*) • Install a finer screen or sand pack filter or re-develop the well • Install a sediment filter on the plumbing system • Seal off joint or the bottom of the casing if either area is allowing overburden to enter the well
	Broken pump or associated parts (e.g. pressure switch).	• Repair or replace pump or parts and chlorinate the well (see Chapter 8: *Well Disinfection*)

Problem	Potential Cause	Possible Action/Rehabilitation
	Worn or split waterlines, split or exposed electrical cables or frayed electrical cable contacts.	• Repair or replace defective components and chlorinate the well (see Chapter 8: *Well Disinfection*)
	Short in the electrical panel.	• Repair or replace defective components
	Drop in groundwater level.	• Lower the pump intake and/or deepen the well. For additional rehabilitation techniques see below
Drop in the groundwater level or no water (after verifying pump is in working order)	Natural causes due to shortages in precipitation to recharge aquifer.	• If the cause is natural, lower the pump intake, deepen the well, construct a new deeper well or supplement with alternate storage facilities (e.g. cistern)
	Well interference (i.e. impacted from other activities in the area that lower the water table or depressurize the aquifer. Some examples of activities which may cause interference include mine, pit, quarry or construction dewatering, removal of material in a quarry or uncontrolled flowing wells).	• If off-site dewatering is the suspected cause contact the local Ministry of the Environment office
	Improper pump selection causing sand movement into the well or bridging.	• Check pump against recommendation on the Well Record to verify that the pump is correctly sized to recommended pumping rate (not the test pumping rate) • In addition to reducing the excessive pumping rate, see possible rehabilitation in the pumping equipment failure “sediment in the well clogging pumping equipment, well screen and plumbing,” above

<table>
<tr><th>Problem</th><th>Potential Cause</th><th>Possible Action/Rehabilitation</th></tr>
<tr><td rowspan="3">Reducing flow rates over time</td><td>Certain types of naturally occurring non-harmful bacteria creating slime and particles (e.g. iron oxidizing bacteria) can clog water intakes on pumps or pumping equipment, well screens and bedrock fractures intersected by well. Iron oxidizing bacteria are a form of biofilm.</td><td rowspan="3">

Use a down-hole video camera to verify problem
Remove and clean the pumping equipment. In some cases removal and replacement of the well screen may be necessary
If biofilm is present, do not highly chlorinate well as biofilm can protect other bacteria and will also significantly harden to the sides of the well
Treat the well by chemical treatment to remove biofilm or mineralization
For biofilm treat the well with acids and biodispersents
For dissolution of minerals treat the well with acid such as hydrochloric acid
Examples of re-developing a well:

Hydrofracturing
Surging (see Chapter 7: Completing the Wells Structure)
Jetting with high pressure water

Disinfect the well using the suggested methods found in Chapter 8: Well Disinfection. As part of well disinfection, the total treatment volume should be a pH controlled chlorine dose that is 5 times the volume of the water well column and creates free chlorine residual between 50 to 200 mg/L in the well and nearby aquifer
Hydrofracturing involves sealing areas of the well using one or more packer device(s) followed by the injection of water under high pressure into the sealed area of the well to dislodge and clean out the bedrock's water producing fractures. Hydrofracturing is for drilled wells using bedrock groundwater sources only.
</td></tr>
<tr><td>Deposits of calcium and magnesium carbonates, manganese or iron can clog plumbing, water intakes on pumps, pumping equipment, well screens and bedrock fractures intersected by well.</td></tr>
<tr><td>Natural plugging of the well intake zone from the aquifer either through the filter pack, well screen or water intake fractures with fine sediments over time.</td></tr>
<tr><td>Bacteria identified in well</td><td>Ponding of surface water in the vicinity of the well.</td><td>

Create a mound around the casing to direct surface water away from the well
Disinfect the well (see Chapter 8: Well Disinfection)
</td></tr>
</table>

Problem	Potential Cause	Possible Action/Rehabilitation
If the well is producing total coliforms or *E. coli* with the raw well water, see Chapter 14: *Abandonment: When to Plug & Seal Wells* and do not drink raw well water	Compromised seal around the casing.	• Replace the seal • Disinfect the well (see Chapter 8: *Well Disinfection*)
	Casing height is below the flood level or below the level where water may be collecting in a well pit.	• Extend the casing and install well caps and vents that prevent surface water and other foreign materials from entering well • Disinfect the well (see Chapter 8: *Well Disinfection*)
	Casing length too short below ground surface. Surface water and near surface sources of contamination can quickly migrate into the well below the short casing.	• Remove short casing and ream hole to proper depth. Install and seal a longer length of well casing that seals off locations where surface water enters well • As an alternative, install and seal smaller diameter casing that is longer than original well casing (typically called a liner). The new casing will also seal off locations where surface water enters well • Disinfect the well (see Chapter 8: *Well Disinfection*)
	Separation distance between well and contamination source is too short. The short pathway allows for contaminants to quickly migrate from the source to the well.	• Remove sources of contamination or abandon (plug and seal) the well and construct a new well at a location that is significantly farther (and preferably up-gradient) from the source of contamination • Disinfect the well (see Chapter 8: *Well Disinfection*) • If necessary, add a water treatment device to plumbing such as a chlorination unit, ultra-violet light system or chlorinator-injector units • If the well is producing total coliforms or *E. coli* with the raw well water, see Chapter 14: *Abandonment: When to Plug & Seal Wells*
	Casing, casing joints or cover of well or well pit is not watertight or is cracked. The openings can allow for surface water or other foreign materials to enter the well pit and well.	• Seal or replace casing, joints or cover for well or well pit • Disinfect the well (see Chapter 8: *Well Disinfection*)
	Well or pumping equipment was not chlorinated	• Clean and Disinfect the well (see Chapter 8: *Well Disinfection*)

Problem	Potential Cause	Possible Action/Rehabilitation
	Off-site contamination source (e.g. sewage or animal lagoon, manure pile, septic system) impairing the aquifer.	• Contact local Ministry of the Environment office to report the contamination • Contact local public health unit for further advice on consuming the well water (see Chapter 8: *Well Disinfection*) • If necessary add a water treatment device to plumbing such as a chlorination unit, ultra-violet light system or chlorinator-injector units • If the well is producing total coliforms or *E. coli* with the raw well water, see Chapter 14: *Abandonment: When to Plug & Seal Wells*
	Cross contamination through the pumping system or from other source (e.g. lake water, cistern water, storage tank.)	• Inspect pumping system for the existence of backflow prevention devices and, if present, determine if they are working properly • Repair or replace defective components • Install backflow prevention devices if not present • Disinfect the well (see Chapter 8: *Well Disinfection*)
Slimy red, black or grey coloured material in water, well or on pumping equipment	Certain types of iron bacteria such as Gallionella, Crenothrix and Leptothrix	• Follow the Actions/Rehabilitation suggestions found in the *Reducing flow rates over time* Problem in this Table (page 25)
Red or black staining on plumbing fixtures and laundry	Naturally occurring iron (rusty colour) or manganese (black colour) causing aesthetic colour and taste issues with the water.	• Use water treatment devices such as greensand filters, aeration devices and in some cases water softeners
Scaling on tubs and sinks	Naturally occurring calcium carbonate minerals are usually associated with wells in limestone bedrock or marble bedrock. Typically know as hardness.	• Install water treatment devices such as softeners

Problem	Potential Cause	Possible Action/Rehabilitation
Blackish water or blackish flakes associated with well water	Naturally occurring iron sulphide causing aesthetic colour issues with the water. Sometimes naturally occurring hydrogen sulphide is associated with this problem. The problem can be initiated by the presence of sulphate reducing bacteria.	• Follow the Actions/Rehabilitation suggestions found in the *Reducing flow rates over time* Problem in this Table (page 25) • Install water treatment devices such as oxidizing filters, chlorination, ozonation, aeration or activated carbon, depending on the concentration • If gas is present, see Chapter 14: *Abandonment: When to Plug & Seal Wells*
Salty taste associated with well water	Naturally occurring sodium and chlorides (or other salt components) causing aesthetic taste issues with the water.	• Install water treatment devices such as reverse-osmosis
	Road de-icing components entering ground water.	• Contact Ministry of Transportation or local road authority to report the road de-icing problem
	Salt from a salt storage facility is leaching into the groundwater.	• Contact local Ministry of the Environment office to report the contamination

Problem	Potential Cause	Possible Action/Rehabilitation
	Backwash from water softener or, septic system effluent high in chloride, discharging into the groundwater.	• If the backwash discharge source is on-site and is the source of the problem, change the discharge location to another approved location • If the problem is caused by water softener backwash discharge, an alternative is to stop using the water softener • See Chapter 14: *Abandonment: When to Plug & Seal Wells* if the chloride concentration is greater than 500 mg/L
Laxative effect after drinking water and bad tastes (where bacteria are not present)	Naturally occurring sulphate causing aesthetic and other issues (e.g. laxative) with the water.	• Install water treatment devices such as reverse-osmosis or distillation • If the sulphate concentration is greater than 500 mg/L, see Chapter 14: *Abandonment: When to Plug & Seal Wells*
Rotten egg odour or corrosion	Low concentrations of naturally occurring hydrogen sulphide gas or sulphate reducing bacteria associated with the groundwater. Sulphate reducing bacteria typically live in anaerobic (non-oxygen environments near the bottom of the well) and will generate hydrogen sulphide gas.	• Follow the Actions/Rehabilitation suggestions found in the *Reducing flow rates over time* Problem in this Table (page 25) • If casing has been corroded, rip out (or ream) existing well casing. Install and seal a new length of well casing and fill annular space with suitable sealant as shown in Chapter 5: *Constructing & Casing the Well* and Chapter 6: *Annular Space & Sealing* • Install water treatment devices such as oxidizing filters, chlorination, ozonation, aeration or activated carbon, depending on the concentration • If gas is present, see Chapter 14: *Abandonment: When to Plug & Seal Wells*

<table>
<tr><th>Problem</th><th>Potential Cause</th><th>Possible Action/Rehabilitation</th></tr>
<tr><td>Presence of poisonous and/or explosive gas as observed by the following:
Gas bubbles escaping from well or observed in a clear glass of well water
Milky colour associated with well water
Gas vapours may sometimes be observed coming off the wellhead
Gas vapours may ignite in the well or building</td><td><u>Hydrogen sulphide</u>
In some cases, naturally occurring elevated concentrations of hydrogen sulphide gas are associated with the groundwater at concentrations elevated above 5 parts per billion range and it is detectable by smell in this concentration range.
At highly elevated concentrations, hydrogen sulphide gas smell is deadened and is invisible.
At elevated concentrations there is a risk of explosions, poisoning or asphyxiation from hydrogen sulphide. At a concentration of 100 parts per million, hydrogen sulphide is immediately dangerous to life and health.
<u>Methane</u>
Naturally occurring elevated concentrations of methane gas are associated with the groundwater in many areas of Ontario.
At elevated concentrations, methane gas is not detectable by smell and is invisible.
At elevated concentrations there is a risk of explosions or asphyxiation from methane.
<u>Other gases</u>
There can be other explosive or poisonous naturally occurring gases in bedrock formations which may contain petroleum hydrocarbons.</td><td>In some cases, the well must be abandoned (properly plugged and sealed)
Use treatment devices, separators and safely vent the entire water system and wellhead
If gas is present, see Chapter 14: Abandonment: When to Plug & Seal Wells
To report the presence of gas, see Chapter 13: Well Records, Documentation, Reporting & Tagging</td></tr>
</table>

Problem	Potential Cause	Possible Action/Rehabilitation
Radon gas has been identified	Due to a natural breakdown of uranium, elevated concentrations of radon gas can be present in soil and bedrock. Radon gas can be poisonous. The gas is odourless and colourless.	• In some cases, the well must be abandoned (properly plugged and sealed) • Install treatment devices and safely vent the entire water system, basement and wellhead • If gas is present, see Chapter 14: *Abandonment: When to Plug & Seal Wells* • To report the presence of gas, see Chapter 13: *Well Records, Documentation, Reporting & Tagging*
Gasoline or fuel oil odour, or rainbow film on water	Possible gasoline or fuel oil contamination. Sources can be a spill or a leak from underground storage tank and distribution lines or a leak from an above ground storage tank. Rainbow film on water may also be caused by naturally occurring phenols from plants.	• Contact local Ministry of the Environment office or Spills Action Centre (1-800-268-6060) to report contamination and the local public health unit for advice • Do not drink raw well water • If the source of contamination is on-site, contact your insurance company or professional environmental consultant to identify, remove and clean-up source • Provide temporary drinking water and if necessary install treatment devices on plumbing • In some cases, the well must be abandoned (properly plugged and sealed) • See Chapter 14: *Abandonment: When to Plug & Seal Wells* if an Ontario Drinking Water Quality Standard such as benzene has been exceeded
Sampling analysis shows raw well water producing fluoride	Naturally occurring minerals associated with Canadian Shield and limestone bedrock deposits. Can result in mottling of children's teeth or in some cases case bone defects.	• In some cases, the well must be abandoned (properly plugged and sealed) • Do not drink raw well water • Install treatment devices on drinking water such as reverse osmosis or distillation • See Chapter 14: *Abandonment: When to Plug & Seal Wells* if an Ontario Drinking Water Quality Standard such as fluoride has been exceeded

Problem	Potential Cause	Possible Action/Rehabilitation
Sampling analysis shows raw well water producing elevated uranium, arsenic or other metals exceeding the Ontario Drinking Water Quality Standards	Naturally occurring minerals associated with Canadian Shield bedrock deposits. Nearby industrial discharges.	• Contact local Ministry of the Environment office or Spills Action Centre (1-800-268-6060) to report contamination and the local public health unit for advice • Do not drink raw well water • Provide temporary drinking water and if necessary install treatment devices on plumbing • In some cases, the well must be abandoned (properly plugged and sealed) • See Chapter 14: *Abandonment: When to Plug & Seal Wells* if an Ontario Drinking Water Quality Standard such as uranium or arsenic have been exceeded
Sampling analysis shows water producing elevated lead	Naturally occurring minerals associated with bedrock deposits. Nearby industrial discharges. Old plumbing pipe and solder to seal plumbing joints. Materials used to seal well screens in older wells (e.g. packers).	• Contact local Ministry of the Environment office or Spills Action Centre (1-800-268-6060) to report contamination and the local public health unit for advice • Do not drink raw well water • Provide temporary drinking water and if necessary install treatment devices on plumbing • In some cases, the well must be abandoned (properly plugged and sealed) • See Chapter 14: *Abandonment: When to Plug & Seal Wells* if the Ontario Drinking Water Quality Standard for lead has been exceeded

Problem	Potential Cause	Possible Action/Rehabilitation
Flood water entering the well	Natural precipitation or snowmelt events causing rivers, lakes and streams to flood area.	• Flood water contains potential pathogens. Pathogens may have entered the well during the flood event • Do not use the well until flood water has left the area; the ground has become unsaturated; and; the well has been rehabilitated • After the flood event, assess the well to ensure the structure is intact. Older hand dug wells constructed with stone may be very unstable due to saturated ground conditions and may need to be plugged and sealed • Upgrade the well by altering it to prevent flooding water from entering the well. There are vents and caps that can prevent flood water from entering the well (see Figure 9-12 and Figure 9-30 in Chapter 9: *Equipment Installation*) • Disinfect the well (see Chapter 8: *Well Disinfection*) • If necessary install treatment devices such as ultraviolet lights or chlorinators if bacterial contamination remains • If the well is producing total coliforms or *E. coli* with the raw well water, see Chapter 14: *Abandonment: When to Plug & Seal Wells*

Best Management Practice – Well Rehabilitation Literature

In addition to Table 11-1 the following books provide further information on the rehabilitation of wells including biofilm and mineralization problems:

Schnieders, John H. 2003. *Cleaning, Disinfection and Decontamination of Water Wells*. Johnson Screens Inc., St. Paul, MN, ISBN 0-9726750-0

Mansuy, Neil. 1998. The Sustainable Well Series - *Water Well Rehabilitation: A Practical Guide to Understanding Well Problems and Solutions*. Layne Geosciences Inc. /CRC Press. ISBN10: 1566703875, ISBN13: 9781566703871

Safety Considerations when Maintaining Wells

There are many serious dangers associated with wells that must be considered when maintaining and repairing a well and precautionary actions to take such as:

- When inspecting a well, make sure that the power supply to the pump has been shut off to minimize the risk of shock or electrocution
- Care must be taken any time the well cover is removed to ensure that people and animals cannot fall into the well

Do not enter any confined space (e.g. non-ventilated areas including well pits, pump house, and others defined in the O. Reg 632/05 under the *Occupational Health and Safety Act*) unless properly trained and equipped. Confined spaces present asphyxiation hazards and some wells produce naturally occurring gases that may be poisonous and/or explosive.

Work on wells should only be completed by experienced well technicians with the correct class of licence (see Chapter 3: *Well Construction Licences: Obtaining, Maintaining & Exemptions)* working for a licensed well contractor. Licensed well technicians should:

- Obtain and follow the guidelines set out in the Material Safety Data Sheet (MSDS) for any chemical product. The MSDS will include the following:
    - Properties of the material
    - Hazards associated with the material
    - Personal Protective Equipment (PPE) required when using the material
    - First aid and medical attention information

- Make sure that all chlorine, acid and other rehabilitation products are approved for use in potable water. Only use products that meet the NSF International Standard 60 for Drinking Water Treatment Chemicals – Health Effects[4], or an equivalent standard
- Avoid using scented bleach or products such as swimming pool chlorine that typically contain additives such as surfactants, thickeners, stabilizers and perfumes, UV inhibitors, algaecides or other additives as they can impair the quality of the water and aquifer after disinfection and are not for potable water use
- Always check product labels to verify product contents and manufacturer's suggested usage as well as MSDS
- Always store chlorine products in a cool, dry and dark environment

Safe practices, as advocated by the Ministry of Labour, must be followed when dealing with chlorine products and solutions, acids and other chemicals (See Chapter 8: *Well Disinfection*).

[4] NSF International Standard/American National Standard 60, 2009. *Drinking Water Treatment Chemicals - Health Effects*. NSF International, Ann Arbor, MI 2009. www.nsf.org

12. Flowing Wells

Chapter Table of Contents

Chapter Figures

Chapter Tables

Chapter Description

This chapter describes flowing wells and how to predict the likelihood of encountering a flowing well. This chapter also discusses how to address flowing conditions when a well is constructed. Due to the serious consequences that could occur as a result of flowing wells, if these conditions are likely to be encountered in an area, there are further resources that should be consulted including experienced professionals and publications.

Regulatory Requirements – Flowing Wells

Relevant Sections – The Wells Regulation

Flowing Well Definition – Subsection 1(1)

Flowing Wells – Section 14.7

Disinfection Exemption - Subsection 15(14)

Venting – Section 15.1

Abandonment – Section 21.1

The Requirements – Plainly Stated

The Wells Regulation requires the following when a flowing well is encountered:

Construction and Device

If the well becomes a flowing well during well construction:

- The well must be constructed to accommodate and be compatible with a device that:
  - controls the discharge of water from within the well casing
  - is capable of stopping the discharge of water from within the well casing
  - is capable of withstanding the freezing of water in the well casing
  - is installed on or in the well
- The construction of the well and the device installed must prevent any:
  - uncontrolled flow of water from the well or at the well site, and
  - backflow of water into the well or well casing.

Abandonment Option

The requirements listed above do not apply if the well is abandoned according to the **Wells Regulation** (for further details see Chapter 15*: Abandonment: How to Plug & Seal Wells*).

Costs

Every contract between the well purchaser and the well contractor for the construction of a well must contain a term that makes the well contractor responsible for the costs of:

- complying with the above requirements, and
- abandoning the well if applicable

The well contractor is not responsible for these costs if there is a written contract between the well contractor and well purchaser that specifically releases the well contractor from these costs.

Venting

If a pump is installed in a new or existing flowing drilled well, an air vent must be installed on the upper end of the casing that allows for an equalization of pressure between the inside of the well casing and the atmosphere. The vent must also allow for the release of all gases from the well. The air vent must meet the minimum size, length and shielding requirements found in the Plainly Stated section of Chapter 9: *Equipment Installation*.

Venting Exemption

A new well in which the casing is used to transmit water out of the well (e.g. flowing well without a well pump) does not need to meet the above air vent requirements.

Chlorination Exemption

The disinfection requirements, found in Chapter 8: *Well Disinfection*, do not apply to flowing wells.

A flowing well means a well that has a static water level above the ground surface.

Static water level means the level attained by water at equilibrium in a well when no water is being taken from the well.

Relevant Sections – Additional Regulations or Legislation

Fisheries Act, R.S. 1985, Chapter F-14.

Ontario Water Resources Act. R.S.O. 1990, Chapter O.40: Sections 30 (Impairment) and 34 to 34.2 (Permit To Take Water)

Ontario Water Resources Act. R.S.O. 1990, Chapter O.40: Ontario Regulation 387/04: Water Taking

Key Concepts

What is a Flowing Well?

A flowing well means a well that has a static water level above the adjacent ground surface. Flowing wells occur when water pressure in the aquifer causes the water level to rise above the ground surface.

There are several things that are important to know with respect to flowing wells:

- In the majority of cases, only confined aquifers hold the potential for flowing wells
- Strong artesian (hydrostatic head) pressure forces groundwater above the ground surface to create a flowing well (see Figure 12-1)
- There are specialized construction techniques and devices that are used when constructing a well in flowing conditions to control the free flow of groundwater from the well
- Improper construction can lower the aquifer's hydraulic pressure, waste groundwater and create flooding problems
- Elevation and loadings (e.g. recharge, discharge) are two hydrogeological factors that create conditions for the development of flowing wells (see Figure 12-3)
- Aquifer recharge events and groundwater withdrawals affect the groundwater level, which may lead to intermittent flowing conditions

FIGURE 12-1: A FLOWING WELL **FIGURE 12-2: A FLOWING WELL**

Figure 12-1 (above left) shows a flowing well discharging groundwater above the top of the well casing and causing a flooding problem. Figure 12-2 (above right) shows another flowing well discharging groundwater above the top of the well casing.

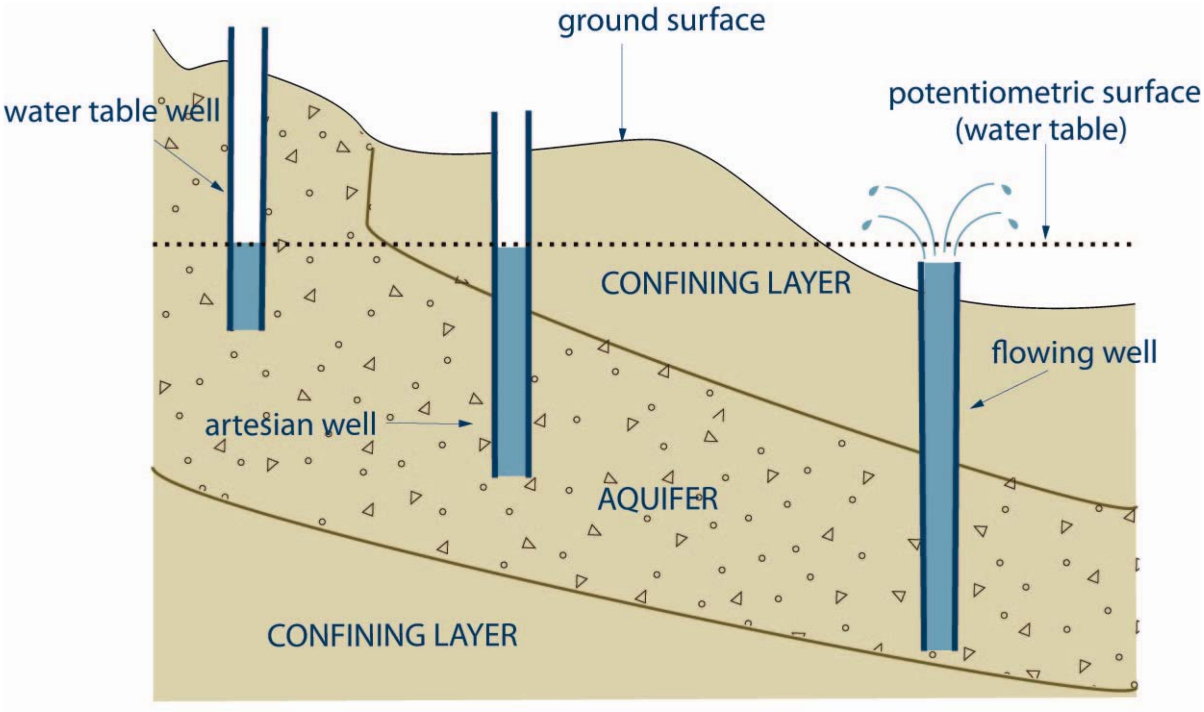


FIGURE 12-3: GEOLOGICAL CONDITIONS THAT CREATE FLOWING WELLS

WHY REGULATE FLOWING WELLS?

It is essential to control flowing wells to:

- Conserve groundwater resources
- Prevent adverse effects to the natural environment such as property damage, flooding, sediment deposition, erosion and surface water impacts
- Preserve the pressure within the aquifer
- Prevent the creation of a direct pathway for contaminants

Construction Considerations When Flowing Conditions are Encountered

There are several factors that should be considered (see Table 12-1 below) to predict the occurrence of flowing well conditions and when constructing wells in areas where flowing conditions may occur. Details are provided on the following pages.

Table 12-1: Important Considerations

Phase	Consideration
I. Predicting	1. Physical setting and local knowledge (e.g. existing flowing wells)
	2. Well records and existing hydrogeological reports
II. Designing	3. Geologic conditions
	4. Depth, pressure and flow of aquifer
	5. Well construction equipment and site specific design

I. Predicting a Flowing Well

Here are two ways to predict the likelihood of a flowing well:

1. Analyzing the Surrounding Physical Setting and Local Knowledge

Possible indicators include a valley location or areas where nearby surface water is at a higher elevation than the area of the proposed well site. The person constructing the well should check for other flowing wells and "springs" in the area. Visible flow at the surface or wet soil conditions may be indicators of flowing well conditions. The person constructing the well or local residents may have general knowledge of the area that suggests possible flowing well conditions.

2. Examining Well Records and Existing Hydrogeological Reports for the Area

Obtaining well records from the Ministry of the Environment (see the *Resources* section of this manual) for nearby wells is an important step in understanding the types of aquifers in the area and should be done prior to beginning construction. In addition, in some areas of Ontario, hydrogeological reports have been produced to identify aquifers that may produce flowing wells. These hydrogeological reports may be found at the local office of the:

- Ministry of the Environment
- Municipality
- Conservation Authority

II. Flowing Well Design

For each type of geology, and depending on the type of construction equipment, there are important factors that should be considered to ensure an efficient flowing well that produces good quality water (see Table 12-1 and design considerations 3, 4 and 5 below).

Best Management Practice – Planning to Control the Flow

Prior to beginning construction in a region known to have flowing well conditions, it is essential that a plan be in place to control the flow of groundwater from the well. The person constructing the well should consider retaining a *Professional Engineer* or *Professional Geoscientist* (consultant) experienced in hydrogeology and flowing well conditions to design the well. If the person constructing the well is unfamiliar with the area or with flowing well conditions, it is important that a licensed well contractor and well technician (of the correct class) experienced with flowing wells be consulted. In some cases, installing a test hole may be appropriate to determine subsurface conditions.

3. Consider the Geologic Conditions

To properly design the well, the geological and hydrogeological environment has to be assessed. This knowledge will determine the best construction process for the well. For example, two different environments requiring different well designs are:

- Competent bedrock has been encountered and a sufficient length of casing has been installed. The person constructing the well may need to seal the casing into the bedrock with a proper concrete grout to ensure flowing water will not rise up through the annular space of the well. This concrete seal has to be able to withstand the expected water pressure. The person constructing the well would then continue to advance the smaller diameter hole inside the casing down to the artesian aquifer in the bedrock.
- A thick [e.g. 30 m (100')] clay layer has been encountered above a sand and gravel formation (artesian aquifer). The person constructing the well may need to advance a large diameter hole and casing to just above the top of the aquifer. The person constructing the well may need to seal the annular space of the larger diameter casing into the clay and then advance a smaller diameter hole and casing through the larger casing into the aquifer. Finally, the person constructing the well would install a seal between the two casings to ensure flowing water will not rise up through the annular space between the well casings.

4. Depth, Pressure and Flow of Aquifer

The location of the recharge zones, thickness of confining layers, elevation of the ground surface, and physical characteristics of the aquifer will determine the likelihood of encountering flowing well conditions. This information should be accurately known, or the person constructing the well should plan for the worst case scenario.

Important definitions[1] are:

Piezometric level - The level to which groundwater in a confined aquifer will rise within a well when no water is being taken from the well. It is the same as the static water level (see Table 1 in Chapter 2: *Definitions & Clarifications*). In the case of a flowing well, the piezometric level is above the ground surface. It is not possible to look at the volume of an artesian well discharge and determine the elevation of the piezometric level. The piezometric level is expressed in metres (or feet) above ground surface.

Artesian head - The hydraulic pressure created within the confined aquifer that drives the water upward in a well to the piezometric level. The distance from the ground surface to the piezometric level, converted into equivalent pressure [expressed as kilopascals (kPA) or pound force per square inch (psi)], is the artesian head.

Downhole hydrostatic head pressure (or DHHP) - The hydrostatic pressure at the top of the artesian aquifer. This pressure results from the combination of the artesian head and a water column extending from the top of the artesian aquifer to the ground surface [expressed as kilopascals (kPA) or pound force per square inch (psi)].

Downward grout pressure (or DGP) - The pressure that must be exerted by the grout (sealant) in order to equalize the DHHP (expressed as kilopascals (kPA) or pound force per square inch (psi)) and stop the flow.

Determining Pressures and Elevations:

Determining pressures and elevations involves measurement, calculations and observations.

When using metric units, the exact pressure conversion from 1 metre of height of water equals 9.8 kPa.

[1] Michigan Department of Environmental. 2005. *Flowing Well Handbook*. Michigan DEQ. Lansing, MI. Available Online: http://www.michigan.gov/documents/deq/deq-wb-dwehs-wcu-flowwellhandbook_221323_7.pdf.

Artesian Head and Piezometric Level (or Static Water Level)

Some methods for measuring artesian head (static water level) are as follows:

1. Installing a pressure gauge on top of the enclosed casing (see Figure 12-5)

   Reading the gauge will provide a measurement in either kilopascals (kPa) or pounds force per square inch (psi). This will provide the artesian head.

   To convert the pressure readings to distance the following conversions are important:

   1 kPa equals 0.1 m or

   1 psi equals 2.31’

   Multiplying the artesian head kPa pressure reading by 0.1 m (or the psi pressure reading by 2.31’) will provide the elevation of the piezometric level (or static water level) in metres (or feet) above the elevation of the pressure gauge.

   piezometric level (metres) = artesian head (kPa) X 0.1 (m/kPa)

   piezometric level (feet) = artesian head (psi) X 2.31 (feet/psi)

   Measuring the distance between the elevation of the pressure gauge to the ground surface and then adding the result to the calculated piezometric elevation will provide the piezometric (static water level) elevation above the ground surface.

2. Extending the open casing to contain the flowing water

   The water level is measured inside the casing above the ground surface. The result will provide the piezometric level (static water level) in metres (feet) above the ground surface.

   To convert the height measurement of a water column to pressure the following conversions are important:

   1 metre equals 10.0 kPa

   1 foot equals 0.433 psi

   Multiplying the piezometric level (or static water level) by 10 kPa (or 0.433 psi) will provide the artesian head pressure in kPa (or psi) above the ground surface.

   artesian head (kPa) = piezometric level (metres) X 10 (kPa/metres)

   artesian head (psi) = piezometric level (feet) X 0.433 (psi/feet)

   One can also attach and extend a small diameter tube on the closed casing to a sufficient height above ground level to contain the static water level in the tube. The water level above the ground surface is measured inside the small diameter tube. The result will provide the piezometric level (static water level) in metres (feet) above the ground surface. The conversion calculation in step 2 (above) can then be used to obtain the artesian head pressure.

Best Management Practice – Determining Pressure Prior to Well Construction

To obtain information about local piezometric head (static water level) conditions in flowing well areas prior to constructing the well, a person constructing a well can, in combination with following the best management practices titled: “Planning to Control the Flow”:

- measure the pressure at a nearby flowing well using a pressure gauge and follow the procedures in Step 1 (above) if a nearby flowing well has been constructed with an appropriate control device. As an alternative, the person could follow Step 3 (above).
- obtain static water level, aquifer and pressure information for an area from hydrogeological reports.

FIGURE 12-4: FLOWING WELL PRESSURE GAUGE DEVICE

FIGURE 12-5: FLOWING WELL PRESSURE GAUGE DEVICE - INSTALLED

EPDM rubber packer is sealed between two stainless steel plates at the bottom of the device. A steel rod with a tightening device and pressure gauge is installed to the packer (Figure 12-4). The packer is installed into the top of the well casing (Figure 12-5). Using the tightening rod, the steel plates squeeze the EPDM rubber to the sides of the well casing which pressurizes the water column. The pressure is detected by the device through the steel rod into the gauge. The gauge provides the artesian head pressure at the elevation of the gauge.

Pressure gauge devices should only be used on new and existing wells that will not allow groundwater to flow up and around the well casing.

Downhole hydrostatic head pressure (DHHP)

To determine the pressure at the top of the aquifer, the measured or calculated piezometric level (static water level) in metres (or feet) above the ground surface is added to the measured level of the top of the aquifer encountered in the well in metres (or feet) below the ground surface. For example, if the peizometric level is 10 m above the ground surface and the depth to the top of the aquifer is 40 m below the ground surface, then the total distance between the two measurements is 50 m (i.e. 10 + 40).

To convert the distance measurement to pressure the following conversions are important:

1 metre equals 10.0 kPa

1 foot equals 0.433 psi

Multiplying the distance in metres (or feet) between the piezometric level (or static water level) to the top of the aquifer by 10 kPa (or 0.433 psi) will provide the downhole hydrostatic head pressure (DHHP) at the top of the aquifer.

Using the above example a distance of 50 m (164') multiplied by 10 kPa (or 0.433 psi) results in a DHHP of 500 kPa (or 71 psi).

Downward grout pressure (DGP)

To contain the flow of groundwater going up the well, the downward grout pressure of the material must overcome the downhole hydrostatic head pressure.

In calculating the downward grout pressure (DGP), manufacturers supply fluid densities of mixtures of bentonite and cement in kilograms per litre (kg/L), pounds per American gallon (lbs/US gallon) and, in some cases, pounds per Imperial gallon (lbs/G).

To covert a fluid density to pressure, the multiplication factor of 9.8 can be used for metric units, 0.043 for Imperial units and 0.052 for American units.

Therefore, DGP can be calculated by:

DGP (kPa) = Grout density (kg/L) × 9.8 × depth to top of artesian aquifer (metres) or

DGP (psi) = Grout density (lbs/G) × 0.043 × depth to top of artesian aquifer (feet) or

DGP (psi) = Grout density (lbs/US gallon) × 0.052 × depth to top of artesian aquifer (feet)

Example of how to apply the DGP:

In the previous example, the DHHP was calculated to be 500 kPa (or 71 psi). The top of the aquifer is 40 m from the ground surface. The multiplication factor is 9.8.

Therefore to determine if a 40 m column of cement mixed with water to a density of 1.8 kg/L will stop the flow and if a 40 m column of bentonite mixed with water to a density of 1.2 kg/L will stop the flow:

The DGP of cement = 1.8 kg/L x 9.8 x 40 m =705.6 kPa.

The DGP of bentonite = 1.2 kg/L x 9.8 x 40 m = 470.4 kPa.

Since the DGP of cement is 205.6 kPa greater than the DHHP of the aquifer, the cement will likely stop the flow.

Since the DGP of bentonite is 29.6 kPa less than the DHHP of the aquifer, the bentonite will likely not stop the flow and thus, groundwater will continue to discharge out of the well.

See the Tools Section at the end of this chapter for kPa and psi conversions.

5. Well Construction Equipment and Site Specific Design

As with the design of any well, it is important to consider the equipment and methods that will be used prior to breaking ground (see Chapter 5: *Constructing & Casing the Well*, for details). When designing a well that is to be installed in an area in which flowing conditions may be encountered, there are additional considerations and equipment that may be required to control the flow.

Well design considerations include:

Drilling systems:

- Typical drilling systems that are used:
    - Rotary (mud, air, reverse)
    - Dual rotary
    - Cable tool
- Systems that are generally not recommended for use when flowing conditions may be encountered:
    - Augering
    - Boring and digging
    - Jetting
    - Driving

Grouting Materials:

- The extra density of cement grouts (i.e. they have a higher downward grout pressure) may allow them to overcome the downhole hydrostatic head pressure better than lighter bentonite slurries. Some grouting materials include:
    - Cement based (e.g. neat cement, high-early strength)
    - Neat cement slurry with accelerator (e.g. calcium chloride)
    - Concrete
    - Bentonite slurry
    - Weighting agent (barite) added to bentonite slurry

Other considerations that affect the design of a flowing well include:

- Depth
- Diameter
- Single casing vs. multiple casing
- Screened well vs. open bottom
- Overburden vs. bedrock aquifer formation
- Naturally developed vs. gravel pack screen
- Aquifer water quality (e.g. high sulphates may affect certain types of cement grout material and high total dissolved solids may affect bentonite)
- Use of the well (e.g. municipal, domestic, monitoring, industrial, commercial)

The potential requirement to obtain a Permit to Take Water (PTTW) from the ministry, or any other approval, is an important consideration and should be determined prior to the construction of the well.

A Permit to Take Water under the *Ontario Water Resources Act* is required when the flow of groundwater freely discharges from a well at a rate that is greater than 50,000 L/ day (11,000 G/Day). Therefore, it is important that the person constructing the well estimate the taking before constructing the well. If the estimate shows the flow will take more than 50,000 L/day, then the person constructing the well needs to obtain a Permit To Take Water from the Ministry. If during construction the person takes more than 50,000 litres of water per day without a permit, the person is subject to enforcement (e.g. orders and charges). More information on Permits to Take Water can be found at: http://www.ene.gov.on.ca/envision/water/pttw.htm

Concerns when Encountering Flowing Conditions[2]

The additional considerations including planning, materials, expertise and equipment needed to properly construct a well under flowing conditions can result in substantial costs not associated with routine well construction. If a flowing well is constructed improperly, the ensuing costs are likely to be even greater, as discussed below.

Damage from Flow Breakout

The uncontrolled discharge of groundwater from flowing wells can cause flooding of the well site and adjacent properties and damage to nearby structures.

Silt, clay, gravel, sand, and drilling fluids can be carried along with the artesian groundwater to the ground surface and eventually reach surface water. This can alter the quality of the surface water and the habitat of aquatic organisms can be impacted.

Colder water temperatures from a flowing well discharge can alter the habitat of warm water aquatic species.

[2] Michigan Department of Environmental Quality. 2005. *Flowing Well Handbook*. Michigan DEQ. Lansing, MI. Available Online: http://www.michigan.gov/documents/deq/deq-wb-dwehs-wcu-flowwellhandbook_221323_7.pdf, Pages 12-13

The uncontrolled discharge of groundwater from flowing wells can cause loss of water pressure and water supply to neighbouring wells.

Flow along the outside of the casing can quickly enlarge the hole and form subsurface voids.

A large volume of geologic material can erupt during a breakout or blowout and create unstable and hazardous conditions at the surface.

Cost of Flowing Conditions

Improper construction, repairs, maintenance and abandonment of a flowing well can be costly.

Unanticipated costs that may arise from flowing conditions include extensive damage to property, restoration of the environment and enforcement (e.g. orders and fines).

Costs associated with individual flowing wells can be in the tens of thousands of dollars and have exceeded one million dollars in Ontario.

Permits and other Regulatory Approvals

Flowing wells will require a Permit To Take Water from the Ministry of the Environment if the flow of groundwater is discharging out of the well at more than 50,000 litres per day during construction or after construction. Other discharge approvals may be necessary if the groundwater from the flowing well discharges into other waters such as a lake, creek or river. Obtaining these permits and approvals can be expensive and time consuming for both the person constructing the well and the well owner.

Figure 12-6: Creation of Subsurface Void

Figure 12-6 shows the back of an orange coloured drilling rig. A black coloured drilled well casing extends out of the muddy water through a rotary table. The drilling rig is holding on to the casing with the rotary table and a welded piece of steel. During drilling the flow around the outside of the casing created a void in the ground. The overburden above the void has collapsed creating a 10 metre (30 foot) deep by 4 metre (13 foot) wide hole filled with water. The void was unknown until the time of overburden collapse. The void created a serious safety issue for anyone working on the back of the drilling rig.

FIGURE 12-7: CREATION OF SUBSURFACE VOID

Figure 12-7 shows the same drilling rig and void shown in Figure 12-6. The drilling rig is slowly falling into the hole jeopardizing the drilling rig. In this case, the well contractor took immediate measures to fill the void and rescued the drilling rig.

DISCHARGE (FLOW) CONTROL[3]

Ontario

The **Wells Regulation** requires that an appropriate device be installed on a well that becomes a flowing well. The device must control the discharge of water from within the well casing. The well must be constructed and the device must be installed in a way that prevents any uncontrolled flow of water from the well or at the well site. The device must be capable of stopping the discharge from within the well casing, must be capable of withstanding the freezing of water in the well casing, and must be compatible with the well.

Proper control of discharge water from a flowing well consists of:

- Controlling, and if necessary, stopping the discharge of water from within the well casing
- Preventing the discharge of water from around the casing by tightly sealing the juncture between the hole wall and the well casing (annular space) and in some cases between two well casings

A device can consist of one or many components installed in or connected to a well. For example:

- An air vacuum valve or a combination air vacuum valve and air release valve may need to be installed on a flowing well packer (Figures 12-8 to 12-10)
- An in-line ball-valve may need to be installed in the waterline or plumbing when using a multiple drawdown seal (Figure 12-11). The following sections provide examples of devices and methods that are compliant with the **Wells Regulation** and some that are not compliant.

[3] Michigan Department of Environmental Quality.. 2005. *Flowing Well Handbook*. Michigan DEQ. Lansing, MI. Available Online: http://www.michigan.gov/documents/deq/deq-wb-dwehs-wcu-flowwellhandbook_221323_7.pdf Page 16.

COMPLIANT DEVICES AND METHODS

When selecting a flow control device, it is important to consider the environmental conditions (e.g. freezing), well design and water pressure within the well. Devices should be assessed to determine if they can withstand the pressure exerted by the water in the well.

There are a variety of devices that can control the flow from within the well casing. The following are examples of flow control devices:

- Flowing well packer (Figures 12-8 to 12-10)
- Drawdown seals (sometimes called flowing well packer) with clamp on pitless adapter (Figure 12-11)
- Flowing well pitless unit, spool type (Figure 12-12)
- Raising the casing above the static water level elevation
- Installing a watertight well cap or welded plate to the top of the well casing

Figures 12-8 to 12-12 illustrate some examples of compliant devices and methods (i.e. they meet the **Wells Regulation** requirements) for controlling and, if necessary, stopping the flow of water from within the well casing.

FIGURE 12-8: FLOWING WELL PACKER

This photograph shows a flowing well packer unit. The unit consists of a packer located at the bottom of a long stainless steel rod. The length of the rod allows the packer to be placed below the frost line. The packer is made out of black coloured EPDM rubber between two stainless steel plates.

The bottom of the packer is equipped with an air vacuum valve or a combined air vacuum and air release valve to ensure that air can move into and out of the well but water cannot do so.

The photograph shows the packer area comes equipped with proper gauged electrical cables. Electrical wiring from the submersible pump in the well can be attached to the cables in the bottom of the unit. Electrical cables can be attached to the top of the packer to allow the wiring to extend out of the well and connect to the electrical service.

At the top of the steel bar is a nut. A socket wrench can be attached to the nut and can turn the steel bar. When installed in the well, turning the bar squeezes the plates and expands the packer to the sides of the well casing.

The manufacturer should be consulted to ensure the various parts of the unit can withstand the pressure exerted by the water column.

See Figures 12-9 and 12-10 for further information on the installation of the flowing well packer.

An air vacuum relief valve is designed to allow air to enter into a system and vent air out of a water system rapidly. Once the water encounters the valve, the weighted ball in the valve seals to the plate in the valve creating a watertight seal, an air release valve allows any gas build up in the water column to slowly vent from the water column while maintaining a watertight seal.

Proper safety precautions and warnings should be provided to all persons who will be repairing and servicing wells with these types of devices as the high water pressure can force packers to be pushed out of a flowing well at high velocity.

FIGURE 12-9: FLOWING WELL PACKER

The flowing well packer shown in Figure 12-9 is being installed in a drilled well that is freely flowing.

At the bottom of the packer is the combined air vacuum valve and air release valve.

The packer is made out of black coloured EPDM rubber between two stainless steel plates. The person installing the device will push the packer into the drilled well using the stainless steel bar.

The red and black electrical wires are also shown extending through watertight seal areas in the packer. Electrical wiring from the submersible pump in the well can be attached to the wires in the bottom of the unit. Electrical wiring can be attached to the top of the unit to allow the wiring to extend out of the well and connect to the electrical service.

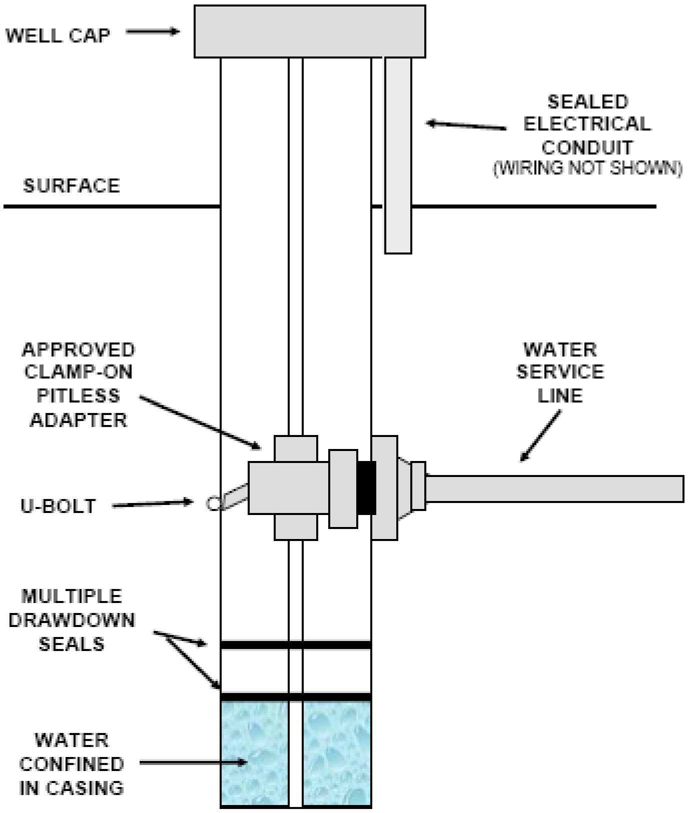
The manufacturer should be consulted to ensure the unit can withstand the pressure exerted by the water column.

FIGURE 12-10: FLOWING WELL PACKER

The photograph shows the flowing well packer installed in the well. A socket wrench has been used to turn the nut attached to the steel bar. Turning the bar forces the steel plates together, expands the EPDM rubber to the side of the steel casing creating a watertight seal and shuts the flowing water off below the frost level.

Typically, a pitless adapter, drop pipe and pump are installed below the flowing well packer. Electrical wires run from the service to the well, through the top of the well casing and attach to the wiring on the packer. Electrical wires from the submersible pump in the well attach to the electrical wires on the bottom of the packer. A typical vermin proof well cap can be installed on top of the well casing with an air vent and a plug in the electrical conduit.

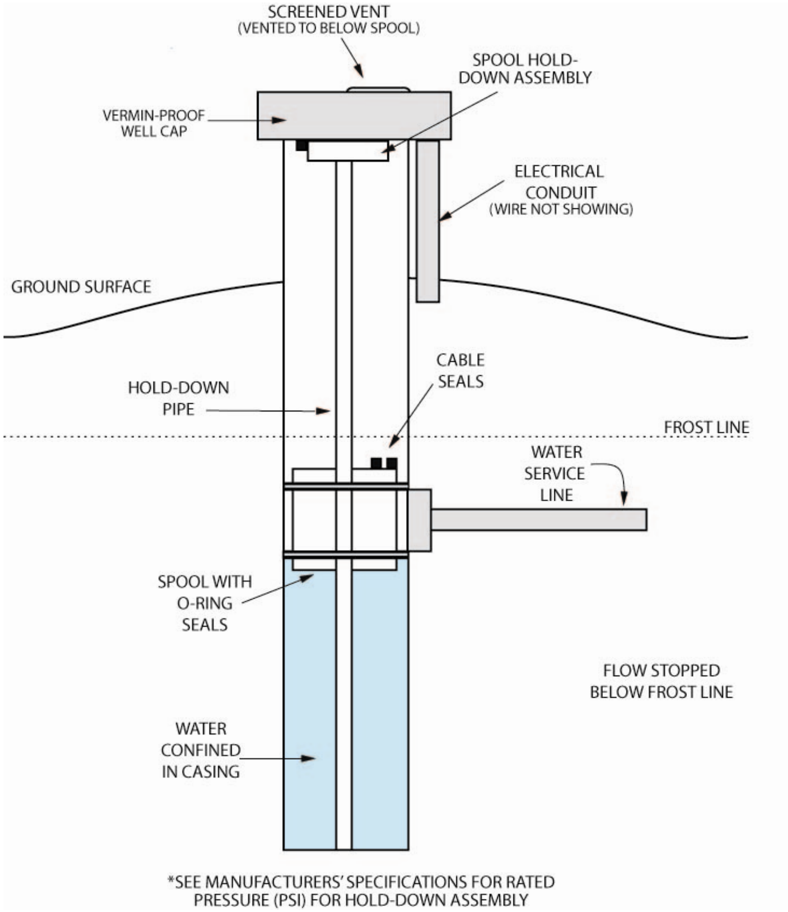
FIGURE 12-11: FLOW CONTROL USING DRAWDOWN SEALS (WITH CLAMP-ON PITLESS ADAPTER)[4]



- The diagram is not to scale, is for illustrative purposes only and does not necessarily represent full compliance with other requirements found in the Wells Regulation (e.g. proper mounding).
- If a pump is installed in the well, an air vacuum relief valve and if necessary, a combined air vacuum relief and air release valve must be installed on the drawdown seals to vent the well.
- The manufacturer should be consulted to ensure the unit can withstand the pressure exerted by the water column.
- These devices can be difficult to repair and service. Proper safety precautions and warnings should be provided to all persons who will be repairing and servicing wells with these types of devices as the high water pressure can force packers to be pushed out of a flowing well at high velocity.

[4] Michigan Department of Environmental Quality. 2005. *Flowing Well Handbook*. Michigan DEQ. Lansing, MI. Available Online: http://www.michigan.gov/documents/deq/deq-wb-dwehs-wcu-flowwellhandbook_221323_7.pdf. Figure 4.

FIGURE 12-12: FLOW CONTROL USING FLOWING WELL PITLESS UNIT – SPOOL TYPE



Pitless units have built in pitless adapters. The pitless unit shown above has a spool and is typically used for industrial and municipal wells.

A vermin-proof well cap sealed to the top of the well casing and a spool hold assembly below the cap hold the spool in place.

The spool consists of rubber rings attached to steel plates. The rings and plates seal to the casing above and below a casing connection to the horizontal pipe. The spool confines the water below the frost line in the well casing. The spool also has areas that allow for electrical cables to run to the submersible pump in the well.

The diagram is not to scale, for illustrative purposes only and does not necessarily represent full compliance with other requirements found in the **Wells Regulation** (e.g. proper mounding).

If a pump is installed in the well, an air vacuum relief valve and, if necessary, a combined air vacuum relief and air release valve must be installed on the system to vent the well.

The manufacturer should be consulted to ensure the unit can withstand the pressure exerted by the water column.

Raising the Well Casing, Installing a Watertight Well Cap or Installing a Welded Cap

In some cases, raising the casing above the static water level elevation or installing a watertight well cap or welded plate on the top of a well casing can stop the flow of water out of the top of the well casing.

In these cases, water above the frost line is prone to freezing in the winter. Casing and caps must be made and installed to withstand cold temperatures and possible freezing.

If a pump is installed in a flowing drilled well, raising the casing or placing a watertight well cap may not be an appropriate device because the well needs to be vented.

Watertight well caps and welded plates on wells can be difficult to repair and service. Proper safety precautions and warnings should be provided to all persons who will be repairing and servicing wells with these types of devices as the high water pressure can force the caps or plates to be pushed out of a flowing well at high velocity.

Non-Compliant Devices and Methods

Figures 12-13 to 12-16 illustrate some examples of non-compliant devices and methods (e.g. they are in violation of the **Wells Regulation**) for controlling the flow.

Figures 12-13 to 12-16 are not to scale and for illustrative purposes only. The diagrams are only intended to show the unapproved flow control method/device and not intended to show other aspects of regulatory compliance (e.g. proper mounding).

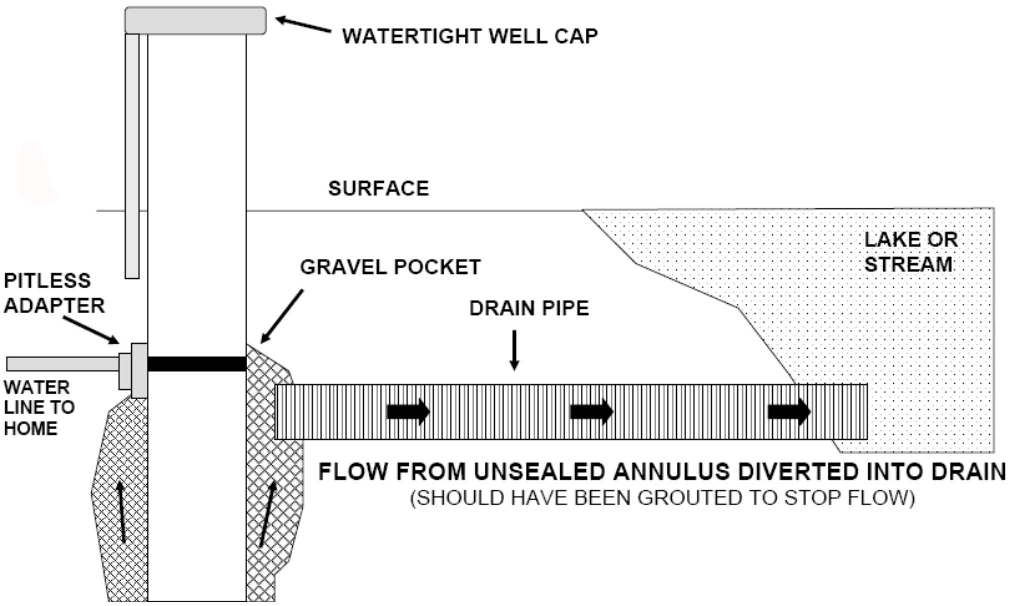


FIGURE 12-13: UNAPPROVED ANNULAR FLOW – DISCHARGE PIPING[5]

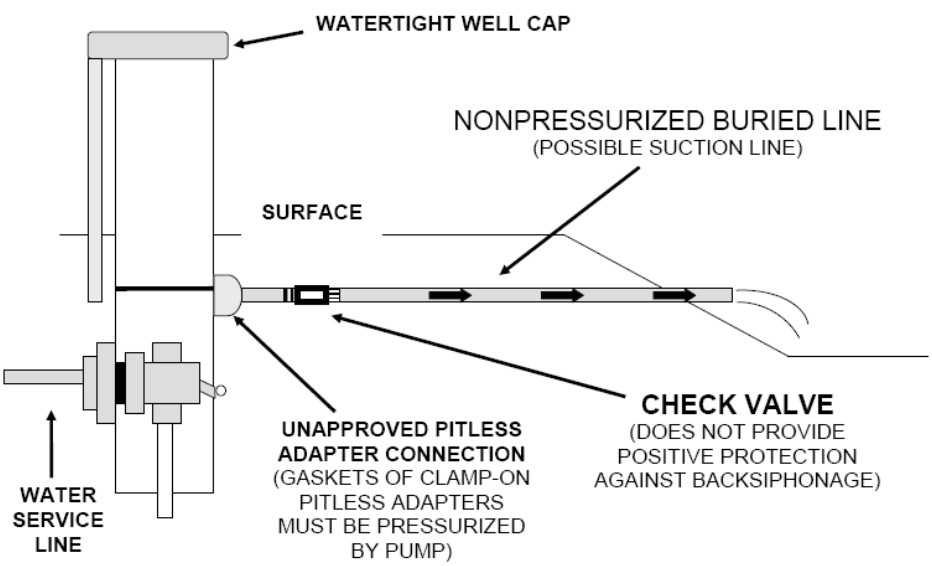


FIGURE 12-14: UNAPPROVED BURIED FLOW DISCHARGE PIPING WITH CHECK VALVE, CONFINING LAYER NOT SEALED[6]

[5] Michigan Department of Environmental Quality. 2005. *Flowing Well Handbook*. Michigan DEQ. Lansing, MI. Available Online: http://www.michigan.gov/documents/deq/deq-wb-dwehs-wcu-flowwellhandbook_221323_7.pdf, Figure 7

[6] Michigan Department of Environmental Quality. 2005. *Flowing Well Handbook*. Michigan DEQ. Lansing, MI. Available Online: http://www.michigan.gov/documents/deq/deq-wb-dwehs-wcu-flowwellhandbook_221323_7.pdf, Figure 8

FIGURE 12-15: UNAPPROVED CONTROL VALVE

The photograph shows that if the valve is shut off, groundwater will overflow from the well through the well cap. In this case, water is flowing out of the well even with the valve open.

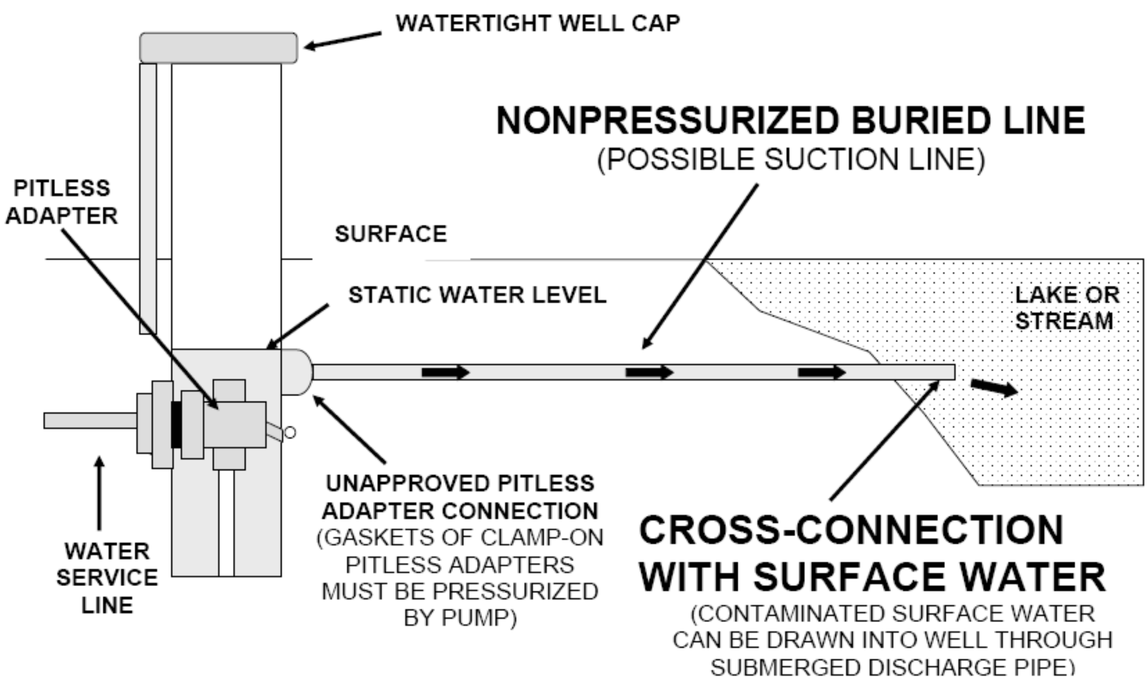


FIGURE 12-16: UNAPPROVED BURIED FLOW DISCHARGE PIPING WITH SUBMERGED INLET[7]

Figure 12-16 is not to scale and for illustrative purposes only. The diagram is only intended to show the unapproved flow control method/device and not intended to show other aspects of regulatory compliance (e.g. proper mounding).

[7] Michigan Department of Environmental Quality. 2005. *Flowing Well Handbook*. Michigan DEQ. Lansing, MI. Available Online: http://www.michigan.gov/documents/deq/deq-wb-dwehs-wcu-flowwellhandbook_221323_7.pdf, Figure 9

Constructing a Well in Flowing Conditions

Before construction begins in a region that is susceptible to flowing conditions, it is essential to have a plan to control the flow of water. The person constructing the well should consider retaining a *Professional Geoscientist* or *Professional Engineer* to design the well as suggested in the Best Management Practice titled *Planning to Control the Flow* (see page 12 of this chapter). If the person constructing the well is unfamiliar with the area or with flowing well conditions, it is important that a licensed well contractor and well technician (of the correct class) experienced with flowing wells be consulted. In some cases, installing a test hole may be appropriate to determine subsurface conditions.

Some considerations and common approaches for well construction when flowing conditions are encountered are described below.

Casing Selection

- The selection of casing materials and wall thickness must take into account the water pressures involved and the potential for freezing. For example, plastic is not recommended for use in flowing conditions.
- Some forms of casing (e.g. plastic) may be structurally weakened by some types of sealants (e.g. heat of hydration from cement grouts).
- Constructing an oversized hole compared to the casing diameter is also extremely important to ensure an adequate volume of sealant is placed in the annular space to contain the flow of any water.
- Due to the high pressure exerted on the casing, the depth to the artesian flowing aquifer is an important consideration in ensuring the structural integrity of the casing. Knowing the depth of the artesian flowing aquifer will aid in determining the appropriate depth, wall thickness and diameter of the permanent outer casing(s).

Casing Installation

- For overburden aquifers, a permanent outer casing should be installed and grouted into the confining layer before an inner well casing is installed through the confining layer into the top of the aquifer.
- For bedrock aquifers, a drive shoe should be attached to the bottom of the casing and then seated securely into the bedrock to create a seal.
- If going through more than one confining layer and aquifer during well construction, the outer casing, when used, must be sealed into the lowest confining layer prior before advancing an inner casing into the production artesian flowing aquifer.
- It is important to take extra care to center the casing in the oversized hole. For example, using centralizers can-create an appropriate annular space to ensure that proper grout placement can occur along the entire length of the casing.
- Long string casings should be kept under tension, not compression during grouting.

WEIGHTING MATERIALS

Drilling and driving a casing into the hole can allow groundwater to escape in an uncontrolled fashion when a flowing well is encountered. Therefore, when dealing with flowing wells, it is common to use drilling fluid (drilling mud) with weighting material to control water while drilling proceeds and to ensure that the hole does not collapse prior to casing installation.

Weighting materials such as barite can be used to:

- increase drilling fluid density while maintaining a proper solids/fluid ratio and viscosity
- control formation pressure
- stabilize the hole

Considerations when selecting a weighting material may include:

- Specific gravity
- Quality (e.g. purity)
- Degree of corrosiveness and abrasiveness
- Chemical inertness

As with grout, the specific gravity of the drilling fluid with weighting material must overcome the downhole hydrostatic head pressure (see II - Flowing Well Design - Step 4: Depth, Pressure and Flow of Aquifer, page 13).

It is important to follow the manufacturer's recommended specifications when using drilling fluid with weighting materials. Manufacturers will have tables and guidelines to assist in obtaining the correct drilling fluid density (see Figure 12-17).

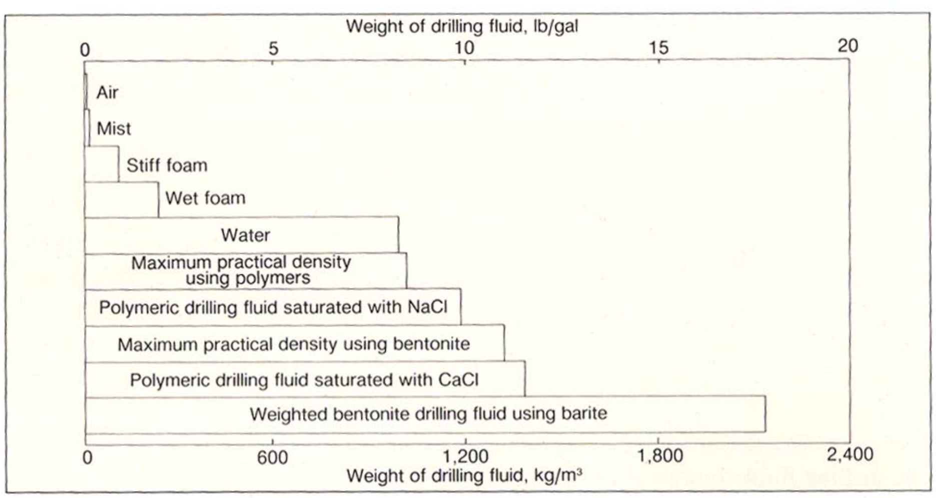


FIGURE 12-17: DENSITIES OF COMMON FLUIDS USED IN WELL CONSTRUCTION [8]

[8] Sterrett, Robert J. 2007. *Groundwater and Wells; Third Edition*. Johnson Screens/a Weatherford Company. New Brighton, MN, Page 300, Figure 8.3.

"Practical drilling fluid densities range from virtually zero for air, to greater than 1,800 kg/m3 (15 lb/gal) for bentonite with barite additives. In general, the density of the drilling fluid must be high enough to balance any confined pressure conditions in the hole. Excessive drilling fluid densities, on the other hand, cause high fluid losses, plugging of the aquifer, unsatisfactory cuttings removal in the mud pit and higher-than-necessary pumping costs."[11]

Grouting

- Grout must be properly placed in the annular space to prevent flowing water problems
- In addition to the methods and considerations described in Chapter 6: *Annular Space & Sealing*, rate of flow and the water pressures must be considered when selecting a grouting method for a flowing well (see Tables 12-2 to 12-4 in the Tools section of this chapter)
- The selection of grouting material and required specific density were previously described in Step 5: Well Construction Equipment and Site Specific Design on page 17
- Cement based grouts must properly set (or cure) to the manufacturer's specifications or 12 hours (whichever is longer)
- Cement slurries with accelerators such as calcium chloride can allow for quicker set times to prevent dilution, washouts and voids (subsurface erosion) around the casing
- Knowledge of how grouts cure (or hydrate) and experience with mixing and placement of grout is important to ensure that the selected sealant (grout) will perform adequately to contain the flow of water
- When grouting a flowing well, extra materials (e.g. cement, calcium chloride (accelerator), fresh water for mixing, extra tremie lines and fittings, weighting agent (e.g. barite and gel products) should be on hand and ready for use
- In some cases, the well may be pumped to lower the water level in the hole to allow the placement of a filter pack and the installation of grout

Flowing Wells Using Other Construction Methods

The use of construction methods such as boring, digging, augering, jetting and driving are generally not recommended where flowing conditions may be encountered. These methods typically pose greater risks and may require additional or different precautions to contain the flow.

Dug, Bored or Driven-Point Wells

The vast majority of dug, bored and driven-point wells are relatively shallow and are located in unconfined aquifers, resulting in a lower likelihood of encountering flowing conditions. However, flowing well conditions can still be encountered during shallow well construction (e.g. near surface water bodies). It is important to take into consideration the indicators of flowing conditions (see page 11) even when constructing these types of wells.

AUGER CONSTRUCTION

Auger methods, such as hollow stem or continuous flight augering, are not recommended if flowing conditions are expected. Augering construction presents serious complications if flowing conditions are encountered since casing and weighting materials are not installed during the augering process. Extra caution should be taken when using augering equipment before breaking through a confining formation and into an aquifer. If caution is not taken and flowing conditions are encountered, it will be difficult to install and seal any type of casing into the confining formation to control the groundwater from the flowing well.

Best Management Practice – Seek Second Party Advice

If the person constructing the well has limited experience with flowing well conditions and there is any possibility of an occurrence of a flowing well while using any of the above construction methods, a *Professional Engineer, Professional Geoscientist* or experienced licensed well technician working for a licensed well contractor should be retained to obtain expert advice before starting. The person should also use this Best Management Practice in combination with the “Planning to Control the Flow” Best Management Practice (see page 12 of this chapter).

SOME SUCCESSFUL CONSTRUCTION METHODS

Figures 12-18 to 12-22 illustrate some methods that have been used successfully in the past when encountering flowing conditions. However, the design for each flowing well must be based on site specific conditions. See the Flowing Well Design section on page 12 of this chapter for details regarding construction considerations when flowing conditions are encountered.

The diagrams on the following pages are not to scale and are for illustrative purposes for this chapter only. The diagrams do not necessarily represent full compliance with other requirements found in the **Wells Regulation** (e.g. proper mounding).

Confined Aquifer in Bedrock Where Flowing Conditions Are Expected (Figures 12-18 to 12-20)

If the confined aquifer is located in solid bedrock, and the bedrock is at or near the ground surface, the drill hole should be significantly oversized and larger than the outer diameter of the casing. The annular space must be sealed to contain (i.e stop the movement of) any flowing water in the annular space. For example, using a neat cement placed in the annular space and allowed to cure to the manufacturer's specifications.

Figure 12-18: Construction Method can be Cable Tool, Rotary Air or Down-the-Hole Hammer - Bedrock Confined Aquifer

Step A.

Initial hole diameter is significantly oversized compared to the finished diameter of the casing, to a depth of at least 6 m (20′). A greater depth may be required to encounter competent rock or to ensure containment.

Step B.

A smaller diameter casing is installed and centred in the oversized hole. Annular space is filled with a suitable grout/sealant that can withstand the downhole hydrostatic head pressure of the aquifer (for details on sealing the annular space see Chapter 6: *Annular Space & Sealing*).

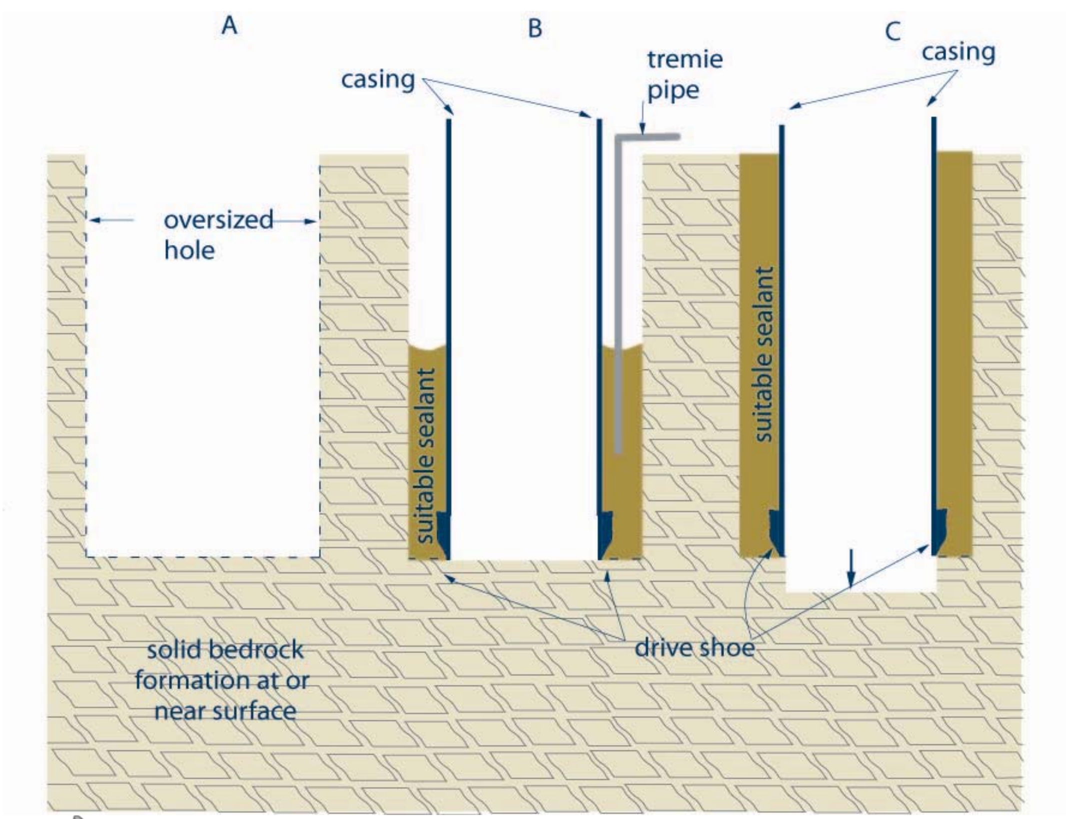
Step C.

The hole is drilled out the bottom of inner casing to the flowing artesian aquifer.

Step D.

A compatible flow control device is installed on the well (see Discharge (Flow) Control, page 20).

Casing must stick up at least 40 cm (16") above the highest point on the ground surface within 3 m radially from the outside of the well casing.



The diagram above is not to scale and is for illustrative purposes for this chapter only.

FIGURE 12-19: ROTARY METHOD USING MULTIPLE CASINGS AND WEIGHTED MATERIALS FOR FLOWING WELL CONSTRUCTION - CONFINED BEDROCK AQUIFER WITH CONFINING LAYER

Step A.

A significantly oversized hole is drilled with weighted drilling fluid (mud) into the confining overburden formation to a depth that is near the top of the confined aquifer.

Note: the hole is oversized compared to the outer casing.

Step B.

The outer casing is centred and set to bottom of the oversized hole.

The annular space is filled with a suitable grout/sealant that can withstand the downhole hydrostatic head pressure of the aquifer.

Step C.

The hole is drilled out through the bottom end of the casing into the top of the aquifer using weighted drilling fluids (mud).

The hole diameter is similar to the inner diameter of the outer casing.

Step D.

The inner casing is set to the top of the aquifer and sealed in place with suitable sealant as described in Step B.

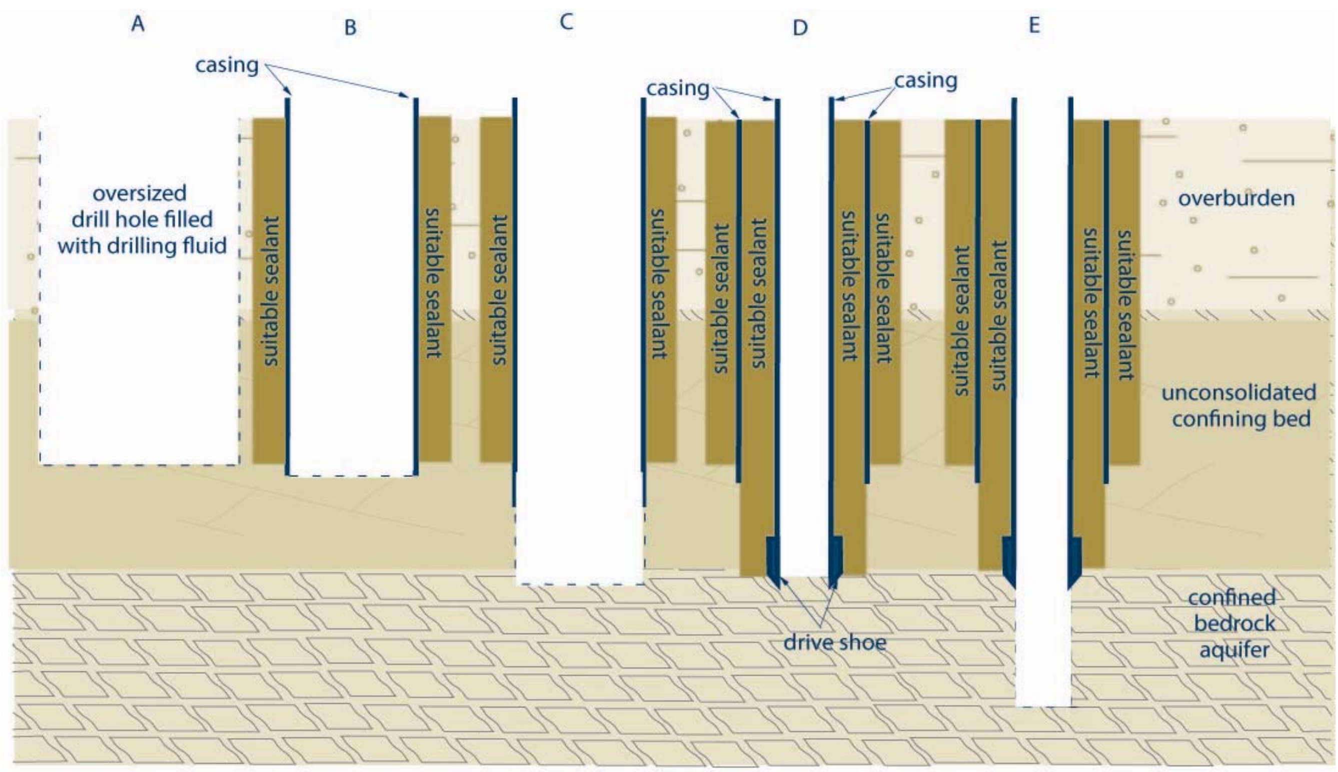
Step E.

After following recommendations to allow grout to set, drilling can continue into the bedrock to the flowing artesian aquifer.

Step F.

A compatible flow control device is installed on the well (see Discharge (Flow) Control, page 20).

Casing must stick up at least 40 cm (16”) above the highest point on the ground surface within 3 m radially from the outside of the well casing.



The diagram above is not to scale and is for illustrative purposes for this chapter only.

When the confined aquifer is located within consolidated material (bedrock), the inner casing should be driven or a smaller diameter hole drilled and the inner casing set firmly into the bedrock.

The annular space around the entire inner casing must be filled from the bedrock to ground surface with suitable sealant. The sealant must be able to withstand the aquifer’s downhole hydrostatic head pressure.

FIGURE 12-20: CABLE TOOL, ROTARY AIR AND DUAL ROTARY METHODS USING MULTIPLE CASINGS AND TEMPORARY CASINGS FOR FLOWING WELL CONSTRUCTION - CONFINED BEDROCK AQUIFER WITH CONFINING LAYER

Step A.

A significantly oversized hole is drilled (1)

Step B.

The temporary outer casing (1) is advanced into the confining overburden formation to a depth that is near the top of the confined aquifer.

The casing is usually installed at the same time as drilling if the formation is susceptible to collapse.

Step C.

The permanent outer casing is centred and set to bottom of the oversized hole.

The annular space between temporary and permanent casings is filled with a suitable grout/sealant that can withstand the downhole hydrostatic head pressure of the aquifer.

The temporary casing (1) is removed.

Step D.

The hole is drilled out through the bottom of the casing (2). The hole diameter is similar to the inner diameter of the outer casing (2).

Weighted drilling fluids (mud) may be used to contain the flow.

An inner casing (3) is installed to the bottom of the hole, seated into bedrock and sealed in place with suitable sealant as described in Step C.

Step E.

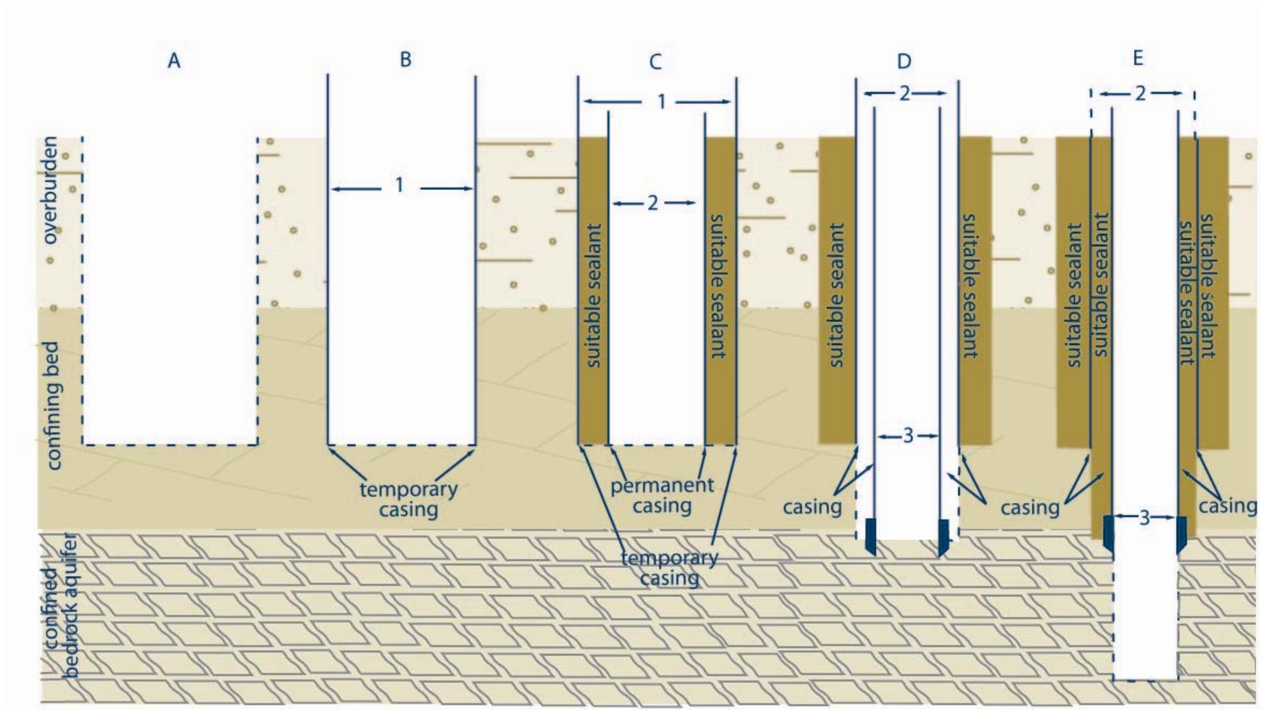
The annular space between inner (3) and outer (2) permanent casings is filled with a suitable grout/sealant that can withstand the downhole hydrostatic head pressure of the aquifer.

After following recommendations to allow grout to set, drilling can continue into the bedrock to the flowing artesian aquifer.

Step F.

A compatible flow control device is installed on the well (see Discharge (Flow) Control, page 20).

At least one casing must stick up at least 40 cm (16”) above the highest point on the ground surface within 3 m radially from the outside of the well casing.



The diagram above is not to scale and is for illustrative purposes for this chapter only.

When the confined aquifer is located within consolidated material (bedrock), the inner casing should be driven or a smaller diameter hole drilled and the casing set firmly into the bedrock.

The annular space around the entire inner casing must be filled from the bedrock to ground surface with suitable sealant. The sealant must be able to withstand the aquifer’s downhole hydrostatic head pressure.

Confined Aquifers in Overburden Where Flowing Conditions Are Expected (Figures 12-21 and 12-22)

- The well should be double cased as a minimum and the annular space should be pressure grouted
- Another method that may be used to control flowing conditions is to set a surface casing, install a packer at the bottom of the casing, install the inner casing, and pressure grout through the packer between the two casings
- The outer casing should be adequately sealed into the impermeable layer to prevent surface and subsurface leakage from the artesian aquifer
- It is important not to extend (i.e. drill) too far into these types of overburden aquifers as high water pressures can cause piping (subsurface erosion), washout and crevasse conditions around the casing during drilling

FIGURE 12-21: ROTARY METHOD USING MULTIPLE CASINGS AND WEIGHTED MATERIALS FOR FLOWING WELL CONSTRUCTION WHERE BOTH CONFINING LAYER AND AQUIFER ARE IN THE OVERBURDEN (DOUBLE CASING CONSTRUCTION)

Step A.

A significantly oversized hole is drilled with weighted drilling fluids (mud) into the confining overburden formation to a depth that is near the top of the confined aquifer.

Note: the hole is oversized compared to the outer casing.

Step B.

The outer casing is centred and set to bottom of oversized hole. The annular space is filled with a suitable grout/sealant that can withstand the downhole hydrostatic head pressure of the aquifer.

Step C.

The hole is drilled out through the bottom of the casing into the top of the aquifer using weighted drilling fluids (mud).

The hole diameter is similar to the inner diameter of the outer casing.

Step D.

The inner casing and well screen of the same diameter are set into the aquifer with weighted mud.

Step E.

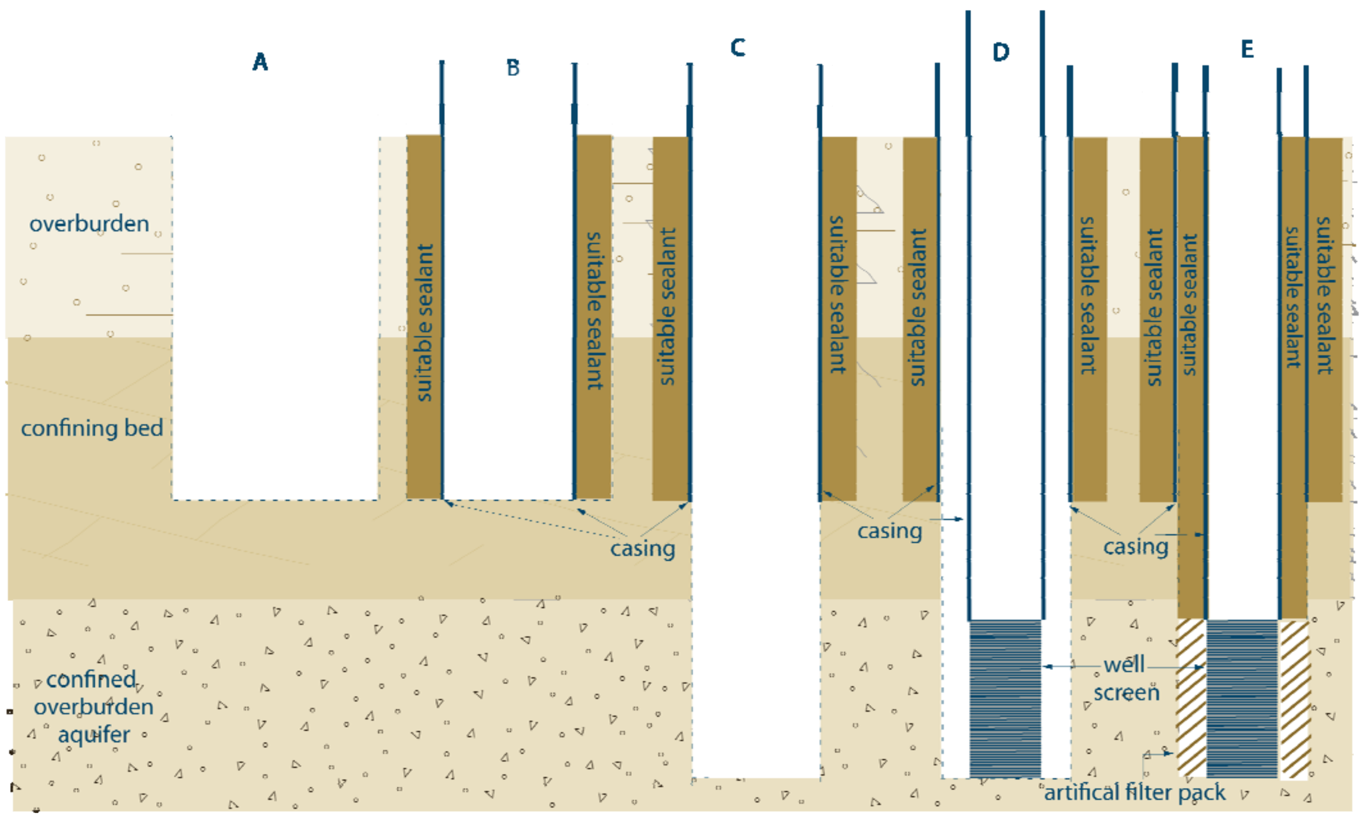
The artificial filter pack is placed around the well screen.

The annular space from the top of the filter pack, including between the permanent casings, is filled with a suitable grout/sealant that can withstand the downhole hydrostatic head pressure of the aquifer.

Step F.

A compatible flow control device is installed on the well (see Discharge (Flow) Control, page 20).

At least one casing must stick up at least 40 cm (16”) above the highest point on the ground surface within 3 m radially from the outside of the well casing.



The diagram above is not to scale and is for illustrative purposes for this chapter only.

FIGURE 12-22: CABLE TOOL, ROTARY AIR AND DUAL ROTARY USING MULTIPLE CASINGS AND TEMPORARY CASINGS FOR FLOWING WELL CONSTRUCTION - CONFINED OVERBURDEN AQUIFER WITH CONFINING LAYER

Step A.

A significantly oversized hole is drilled into the confining overburden formation to a depth that is near the top of the confined aquifer.

Step B.

A temporary outer casing (1) is advanced into the confining overburden formation to a depth that is near the top of the confined aquifer.

Note: the hole is oversized compared to the permanent outer casing.

Step C.

The permanent outer casing (2) is centred and set to the bottom of the temporary casing.

Step D

The annular space between temporary (1) and permanent (2) casings is filled with a suitable grout/sealant that can withstand the downhole hydrostatic head pressure of the aquifer.

Step E.

The temporary casing (1) is removed

Step F

The hole is drilled out through the bottom of the casing (2) while advancing an inner casing into the top of the aquifer (3). The hole diameter is similar to the inner diameter of the permanent outer casing.

Weighted drilling fluids (mud) may be used to contain the flow.

Step G.

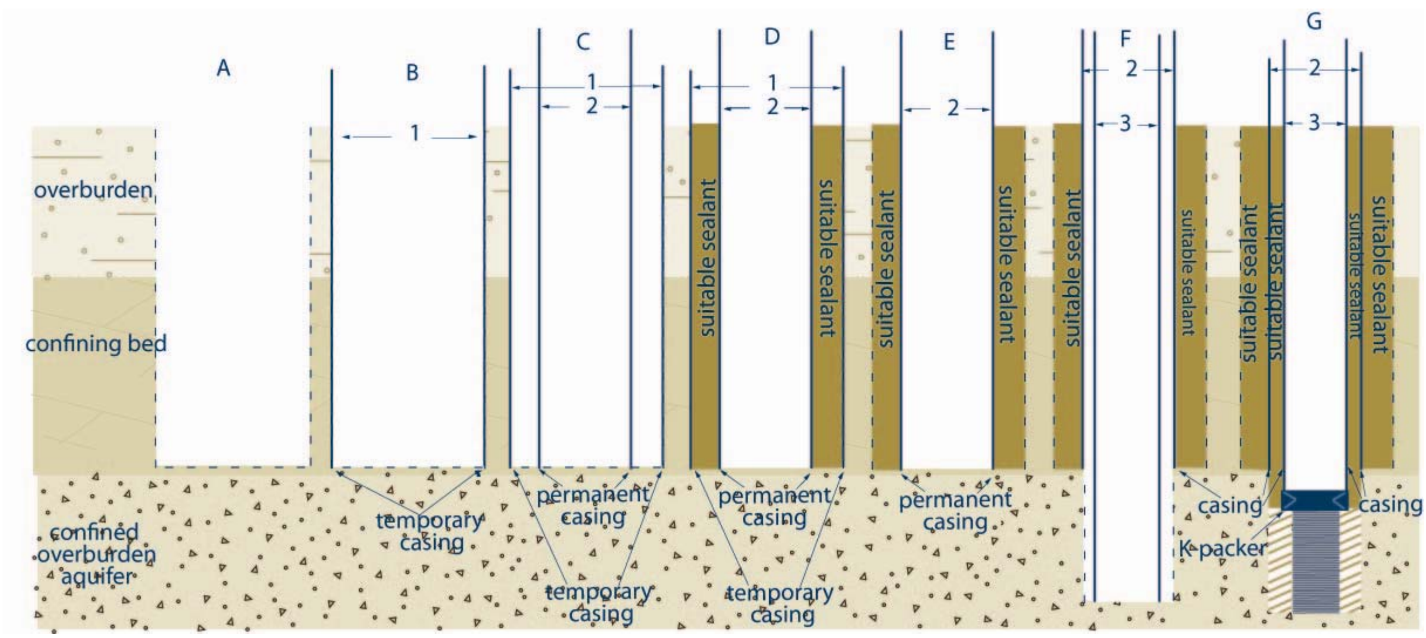
A telescopic well screen is installed at the bottom of the casing and the casing is pulled back to expose the well screen to the formation.

The annular space from the top of the filter pack, including between the permanent casings, is filled with a suitable grout/sealant that can withstand the downhole hydrostatic head pressure of the aquifer.

Step H.

A compatible flow control device is installed on the well (see Discharge (Flow) Control, page 20).

At least one casing must stick up at least 40 cm (16”) above the highest point on the ground surface within 3 m radially from the outside of the well casing.



The diagram above is not to scale and is for illustrative purposes for this chapter only.

ENCOUNTERING A FLOWING WELL UNEXPECTEDLY

When constructing a well, including pump and equipment installation and alteration, it is possible that a flowing well situation may be unexpectedly encountered. This is a situation that can become seriously problematic very quickly. It is important to always be prepared and know:

1. How to control and stop an unexpected flowing well as explained in this chapter.
2. How to abandon an unexpected flowing well as explained in Chapter 15: *Abandonment: How to Plug & Seal Wells*.

WELL CONTRACTOR RESPONSIBLE FOR COSTS

If during well construction (including installing a pump and any alterations), the well water starts to flow above the ground surface, the well contractor is responsible for the cost of complying with the flowing well construction or abandonment requirements in the **Wells Regulation** (see Plainly Stated section of this chapter).

This includes the following actions and any costs associated with them:

- The proper construction of the well that prevents any uncontrolled flow from the well (which includes the area around the well casing) or at the well site and the installation of an appropriate device that:
  - controls the discharge of water from within the well casing,
  - is capable of stopping the flow of water from within the well casing,
  - is capable of withstanding the freezing of water in the well casing, and
  - prevents the backflow of water into the well, or
- The abandonment of the well in accordance with the **Wells Regulation** requirements (see Chapter 15: *Abandonment: How to Plug & Seal Wells*).

The well contractor is responsible for all associated costs to control or abandon the flowing well unless the well contractor has placed a special clause in the written contract with the well purchaser that explicitly relieves the well contractor from these costs.

Even if the well contractor is relieved from the costs, the person constructing the well must still meet the **Wells Regulation** requirements to control or abandon the flowing well, as stated in the Plainly Stated section of this chapter.

Consulting a Professional

Best Management Practice – Consulting a Professional for Unexpected Flowing Wells

The person constructing the well should immediately retain a *Professional Geoscientist* or *Professional Engineer* (consultant) experienced in hydrogeology and flowing well conditions, to assess the unexpected flowing well and the hydrogeology around the flowing well.

After the consultant has assessed the flowing well and the hydrogeology around the well, the consultant should provide the person constructing the well with recommendation(s) to either abandon the well or on how to properly construct the well and install an appropriate device to control, and if necessary, shut off the flow of water from the well.

The person constructing the well should immediately implement the consultant's recommendations to prevent any adverse effects such as flooding. As a suggestion, the well contractor could have the consultant observe the rectification operation at the flowing well to ensure the recommendations are followed.

Installing Pumps in Existing Flowing Wells or where a well becomes a flowing well after it has been constructed.

There are many health and safety concerns when working on existing flowing wells with control devices. The high pressures in the water column can cause devices such as packers and portions of the adapters to be pushed out of a flowing well at high velocities. There have been cases of people being seriously injured trying to remove control devices.

The removal of devices has also resulted in flooding problems, the discharge of contaminated well water into surface water and flows exceeding 50,000 litres per day without a Permit To Take Water from the Ministry.

It is important that proper safety and environmental precautions (including obtaining any environmental approvals such as a Permit To Take Water (see page 18)) be observed by anyone who will be repairing and servicing wells with these types of devices to avoid injury and protect the environment.

There are also many concerns when working on existing flowing wells that do not have control devices. See the "Concerns when Encountering Flowing Conditions" section on p.18 of this chapter for some of the legal liabilities.

Best Management Practice – Consulting a Professional for Existing Flowing Wells

Prior to working on an existing flowing well or if the well suddenly becomes a flowing well, a person should consider retaining a *Professional Geoscientist* or *Professional Engineer* (consultant) experienced in hydrogeology and flowing well conditions to assess the flowing well and the hydrogeology around the flowing well.

After the consultant has assessed the flowing well and the hydrogeology around the well, the consultant should provide the person constructing the well or well owner with recommendation(s) to:

- properly upgrade the well,
- abandon the well and construct a new well, or
- install an appropriate flow control device.

The consultant's recommendations should be implemented. If a person constructing the well is unfamiliar with the area or with repairing flowing wells, it is important that a licensed well contractor and well technician (of the correct class) experienced with flowing wells be consulted and if necessary, retained to do the work.

TOOLS

Legend for Tables 12-2 and 12-3: Grouting Material Suitability Using Common Neat Cement and Bentonite Products

Use this legend in conjunction with In Tables 12-2 and 12-3 found on pages 44 and 45.

	Heavy Enough to Overcome Hydrostatic Pressure	**Not** Heavy Enough to Overcome Hydrostatic
	Neat cement grout with a density of 1.8 kg/L with weight additives	Bentonite grout with a density of 1.14 kg/L Bentonite grout with a density of 1.25 kg/L
	Neat cement grout with a density of 1.8 kg/L	Bentonite grout with a density of 1.14 kg/L
	Bentonite grout with a density of 1.25 kg/L Neat cement grout with a density of 1.8 kg/L	Bentonite grout with a density of 1.14 kg/L
	Bentonite grout with a density of 1.14 kg/L	N/A

Example of use of Legend for Tables 12-2 and 12-3: Where the top of the aquifer is 3 metres below the ground surface and the piezometric level is 1 metre above the ground surface, the corresponding pressure is calculated to be 39 kPa. The light blue/grey colour indicates a column of 3 metres (distance from ground surface to aquifer in well) of neat cement grout with a fluid density of at least 1.8 kg/L or neat cement grout with weight additives will overcome the aquifer's downhole hydrostatic head pressure of 39 kPa. However none of the common bentonite grouts listed will overcome the downhole hydrostatic head pressure. The listed bentonite grouts will not stop the flow of groundwater out of the well.

The tables provide for common grouting products used in the industry to overcome flowing well conditions. It is important that persons trying to overcome flowing wells verify and calculate the density of the grouting mixture before using these tables.

After mixing the material at the site, fluid density can be verified in the field using a mud balance

Table 12-2: Downhole Hydrostatic Head Pressures (kPa) for Flowing Artesian Wells and Common Grouting Materials Used to Overcome the pressure – depths provided in metres

Depth to top of flowing aquifer from ground surface in **metres.**	Pressure from grout in kPa with Density of 1.8 kg/L	Pressure from grout in kPa with Density of 1.25 kg/L	Pressure from grout in kPa with Density of 1.14 kg/L	Downhole hydrostatic pressure in **kPa** for various piezometric levels above ground surface measured in **metres**.					
				1 m	2 m	4 m	6 m	8 m	10 m
3	53	37	34	39	49	69	88	108	127
6	106	74	67	69	78	98	118	137	157
10	176	123	112	108	118	137	157	176	196
15	265	184	168	157	167	186	206	225	245
20	353	245	223	206	216	235	255	274	294
25	441	306	279	255	265	284	304	323	343
30	529	368	335	304	314	333	353	372	392
35	617	429	391	353	363	382	402	421	441
40	706	490	447	402	412	431	451	470	490
50	882	613	559	500	510	529	549	568	588
60	1058	735	670	598	608	627	647	666	686
70	1235	858	782	696	706	725	745	764	784
80	1411	980	894	794	804	823	843	862	882

This table has been prepared using the conversion factor: 1 m = 9.8 kPa

Table 12-3: Downhole Hydrostatic Head Pressures (psi) for Flowing Artesian Wells and Common Grouting Materials Used to Overcome the pressure – depths provided in feet

Depth to top of flowing aquifer from ground surface in **feet.**	Pressure from grout in psi with Density of 15 lbs/US gal or 18 lbs/Imp Gal	Pressure from grout in psi with Density of 10.4 lbs/US gal or 12.5 lbs/Imp Gal	Pressure from grout in psi with Density of 9.5 lbs/US gal or 11.4 lbs/Imp Gal	Downhole hydrostatic head pressure in **psi** for various piezometric levels above ground surface measured in **feet**.					
				5 ft	10 ft	15 ft	20 ft	25 ft	30 ft
10	8	5	5	6	9	11	13	15	17
20	16	11	10	11	13	15	17	19	22
30	23	16	15	15	17	19	22	24	26
40	31	22	20	19	22	24	26	28	30
50	39	27	25	24	26	28	30	32	35
75	59	41	37	35	37	39	41	43	45
100	78	54	49	45	48	50	52	54	56
125	98	68	62	56	58	61	63	65	67
150	117	81	74	67	69	71	74	76	78
175	137	95	86	78	80	82	84	87	89
200	156	108	99	89	91	93	95	97	100
225	176	122	111	100	102	104	106	108	110
250	195	135	124	110	113	115	117	119	121

This table has been prepared using the conversion factor: 1 ft = 0.433 psi

In Tables 12-2 and 12-3 the top of the aquifer is added to the piezometric level above the ground surface. If the measurement is in metres, then the total measurement is multiplied by 10 to give the pressure in kPa. If the measurement is in feet, then the total measurement is multiplied by 0.433 to give the pressure in psi. For example, where the top of the aquifer is 3 m and the piezometric level is 1.5 m, then the total measurement is 4.5 m. 4.5 m x 10 converts to 45 kPa.

Table 12-4: Common Grouting Materials, vs. Weight (fluid density) vs. Hydrostatic Pressure

Material	Density	Hydrostatic Pressure in kPa (or psi) per metre (or per foot)
Neat Cement @ 23 L (6 US gal) water/sack:	1.80 kg/L	17.64 kPa/m
	18.0 lbs/gal	0.78 psi/ft
	15.0 lb/US gal	0.78psi/ft
Bentonite Slurry Grout:	1.25 kg/L	12.25 kPa/m
	12.5 lbs/gal	0.54 psi/ft
	10.4 lb/US gal	0.54 psi/ft
Bentonite Slurry Grout:	1.14 kg/L	11.17 kPa/m
	11.4 lbs/gal	0.49 psi/ft
	9.5 lb/US gal	0.49 psi/ft

In Table 12-4 the conversion from fluid density to pressure is multiply by 9.8 for kg/L to kPa/m, 0.043 for lbs/gal to psi/foot and 0.052 for lbs/US gal to psi/foot.

13.Well Records, Documentation, Reporting & Tagging

Chapter Table of Contents

Chapter Figures

Chapter Description

This chapter covers the requirements of completing and keeping accurate logs of overburden and bedrock materials (geologic log), field notes and well records. Reporting, notification and submission requirements are discussed in detail. Requirements for well tags are covered.

Regulatory Requirements – Well Records, Information, Documentation, Reporting & Tagging

Relevant Sections – The Wells Regulation

Log and Field Notes – Section 12.1

Well Yield – Clause 14.10(1)d and Subsection 14.10(3)

Well Tags – Sections 14.11 and 22

Disinfection* (Reporting *Free Chlorine Residual*) *–Subsection 15(9)

Information – Sections 16, 16.1 and 16.2

Well Record* (*Single Well*) *–Section 16.3

Well Record* (*Abandonment*) *– Section 16.5

The Requirements – Plainly Stated

The Wells Regulation requires the following

Log and Field Notes

Every person constructing a well must make a log of overburden and bedrock materials and have it available at the well site for inspection, unless the person constructing the well is:

- constructing a well by the use of a driven point,
- altering a well without deepening it, or
- only installing a pump.

A log of overburden and bedrock materials is not required to be made for a well abandonment (plugging and sealing).

In all cases every person constructing a well or every person abandoning a well (often the well owner) is required to make and have available at the well site, for inspection, field notes that include an up to date record of the construction or abandonment activities.

Well Yield

Water levels and pumping rates must be recorded on the well record (see Chapter 10: *Yield Test*).

The Wells Regulation requires the following (continued)

Well Tags for New Wells

Before the structural stage of a new cased well is completed, the person constructing the well must affix a well tag, issued by the Ministry, permanently to the outside of the casing or to a permanent structure associated with the well. The affixed tag must be visible and must not be obstructed by the well cap or other well components or by equipment associated with the well.

Well Tags for Alterations to Existing Wells

If alterations (other than minor alterations) are made to a cased well that does not have a well tag, a Ministry well tag must be obtained and affixed permanently to the outside of the casing or to a permanent structure associated with the well as per above (see Well Tags for New Wells).

During alterations to a cased well with a well tag, the well tag must be safeguarded and, if removed, it must be re-affixed permanently to the outside of the casing or to a permanent structure associated with the well before completion of the alteration as above (see Well Tags for New Wells).

During alterations, including minor alterations, to a cased well with a well tag, if the existing well tag is broken, defaced, illegible or otherwise unusable, the person constructing the well must:

- remove the well tag and return it to the Director no later than the date that the well record is submitted to the Director (within 30 days after affixing the new well tag),
- before completing alterations, affix a new well tag issued by the ministry as per above (see Well Tags for New Wells), and
- complete a well record with respect to the replacement of the well tag and submit the well record to the Director within 30 days after affixing the new well tag.

Well Tags – Defacing/Removing

It is not permitted to deface, alter, conceal or obstruct a well tag.

It is not permitted to remove a well tag that is affixed to a well unless the:

- person has the written consent from the Director,
- well tag on the well that is being altered is broken, defaced, illegible or otherwise unusable, or
- well is being altered or plugged and sealed.

It is not permitted to use a well tag issued by the Ministry **except** in accordance with the **Wells Regulation**.

See Chapter 2: *Definitions & Clarifications* “Table 2-1” and “Table 2-2”, for definition of minor alteration and clarification of the term routine repair.

Reporting Free Chlorine Residual Records

Before the well is used as a source of water for human consumption, the person who disinfects and tests the well water for free chorine residual must provide the well purchaser with a written record of the test results (see Chapter 8: *Well Disinfection*).

The Wells Regulation requires the following (continued):

Notification

Mineralized Water

Where a well is constructed and mineralized water is encountered, the person constructing the well must immediately notify the well purchaser and the owner of the land on which the well is located of the condition.

Natural Gas or Other Gas

Where a well is constructed and natural gas is encountered, the person constructing the well must immediately notify the well purchaser, the owner of the land on which the well is located, and the Director of the condition.

Information for the Well Purchaser

After Structural Stage

Unless the well purchaser otherwise directs, on the day that the structural stage is complete, the person constructing the well (other than a minor alteration) must:

- Deliver an information package from the ministry to the well purchaser;
- Provide a water sample, of at least one litre, to the well purchaser for visual examination, and
- Measure the depth of the well in the presence of the well purchaser.

Pump Replacement

Unless the well purchaser otherwise directs, on the day that a pump (which includes associated equipment) is replaced in an existing well, the person installing the pump must:

- Deliver an information package from the ministry to the well purchaser.

Single Well Record

On completion of a well's structural stage (other than minor alterations or the installation of a pump), the person constructing the well must:

- Complete a well record for the well in full detail following the instructions and explanations on the record,
- Within 14 days, deliver a copy of the well record to the well purchaser and the owner of the land on which the well is situated,
- Within 30 days, forward a copy of the well record to the Director, and
- Retain a copy of the well record for at least two years.

On completion of the abandonment of a well, the person abandoning the well (often the well owner) must:

- Complete a well record for the well, in full detail, in accordance with the instructions and explanations on the record,
- Within 14 days after the date on which the well construction equipment is removed from the site, deliver a copy of the well record to the owner of the land on which the well is situated, and
- Within 30 days after the date on which the well construction equipment is removed from the site, forward a copy of the well record and any well tag that was removed from the well, to the Director.

See the “Well Record Information” section of this chapter for further clarification on the term “person constructing the well”. See the “Alterations,” section of this Chapter (page 23) of this chapter and see Chapter 11: *Maintenance and Repair*, “Requirements for Repairs and Alterations on Existing Wells” section for clarification of the term “alteration” and “minor alteration”. See Chapter 2: *Definitions and Clarifications,* “Table 2-1” for definition and clarification of the terms “well’s structural stage” and “minor alteration”.

Key Concepts

Log and Field Notes

Every person constructing or abandoning a well is required to keep, and have available at the well site for inspection, field notes that include an up-to-date record of the construction activities. In many cases, a log of overburden and bedrock materials is also required.

Keeping accurate field notes is important for the following reasons:

- To complete the well record. The information transposed onto the well record may be used by the water well industry and environmental consultants seeking information on groundwater resources in an area (see “Well Record and Well Tag” section below).
- To document construction activities, field conditions, incidents and subsurface information prior to the completion of the well record.

Well Record & Well Tag

Well records provide construction and general water quantity and quality information. The well tag is a unique identifier that links the well in the field with the well record. Well records and tags are a notification system for use by the province, consultants, contractors and well owners to:

- Provide information on the groundwater and geology of an area, including:
    - Groundwater availability
    - General idea of depth to water
    - Possible flowing well conditions
    - Equipment needs
    - Estimated costs
    - Details in case of spills
    - Help protect well owners and contractors from liability issues with the Ministry
- Provide information to manage the groundwater resources
- Provide information for consultants and regulators on groundwater quality and quantity issues in the area
- Assist in locating wells to ensure the wells are being properly maintained or plugged

Some water quantity (e.g. recommended pumping rates) and quality observations reported on the well record are considered to be general information only, as the information is used for many purposes. For example, homeowners and real estate brokers use well records to identify well depths and original yields.

Information from well records is compiled at the Ministry. Together, with other databases and geographical information systems (GIS), the information provides an overview of groundwater and aquifers in Ontario, including:

- Types of construction, uses and locations of wells in the province
- Patterns, such as areas of natural gas and flowing wells
- Location of low and high-yield aquifers

Everyone, including water well contractors, technicians, well owners, consulting engineers and geoscientists, municipal water operators and regulators benefit from having well record information. For example, where there is little geotechnical information in an area, the general information on area well records can be used by *Professional Geoscientists* or *Professional Engineers*. *Professional Geoscientists* or *Professional Engineers* use the record's general information to design and construct special geotechnical holes for their assessments. Then *Professional Geoscientists* or *Professional Engineers* observe and sample overburden and bedrock formations from geotechnical holes and make the appropriate geotechnical interpretations for geological and hydrogeological reports. As another example, the Ministry of the Environment, municipalities, and conservation authorities use well record information to protect Ontario's source water.

NOTIFICATION

Ontario

Where a well is constructed, the person constructing the well must immediately notify the well purchaser and the owner of the land on which the well is located if natural gas or mineralized water is encountered to:

- Protect drinking water supplies
- Protect the environment and property
- Protect health and safety
- Take additional precautions (e.g. equipment to remove or treat)

Where a well is constructed and natural gas is encountered, the person constructing the well must also immediately notify the Director (e.g. Spills Action Centre 1-800 268- 6060) of the condition.

Log and Field Notes

Every person constructing or abandoning a well is required to make and keep field notes that include an up-to-date record of the construction or abandonment of the well. In addition, every person constructing a well is required to make and keep a log of overburden and bedrock materials unless the person is constructing a well by the use of a driven point, altering a well without deepening it, or installing a pump (including associated equipment and alterations necessary to install the equipment). A log of overburden and bedrock materials is not required if a person is abandoning a well. The log and field notes must be kept at the well site and be available for inspection.

Best Management Practice – Detailed Log of Construction Activities

Keeping a detailed log of all the well construction activities will assist in completing the well record.

The person constructing the well should collect representative samples at measured depths and at intervals that will show the complete geological character of the hole. For example, formation samples could be collected at 1.5 m (5′) intervals and at every change in formation materials. The field notes should document the:

- Changes in formation materials including the top and bottom of each material/unit encountered,
- Observed characteristics of each formation unit,
- Depth to groundwater, water quality and gas observations,
- Materials and equipment used at the site and in the well, and
- Location information.

Table 5-6 (Particle Sizes for Overburden Material) in Chapter 5: *Constructing & Casing the Well* can be used as an aid to describing overburden material.

Best Management Practice – Documenting Subsurface Conditions

Subsurface conditions should always be documented in the log and field notes for future reference as this may:

- Offer assistance for dispute resolution
- Supplement the information on the well record form to assist in addressing problems associated with the well

The person working at the abandonment of a well can assist the person abandoning the well (often the well owner) in completing the field notes (see the note in the "Well Record Information" section of this chapter for clarification of the term "person abandoning the well").

Sample Log Book Entry

As shown in Figure 13-1**,** observations of overburden and bedrock materials, construction, quantity and quality information are recorded in the log book. Observations recorded in the log book can then be reported on a well record. A copy of this log can be found in the "Tools" section of this chapter and copies can be made for use in the field.

LOG

NAME OF WELL TECHNICIAN Joe Brown
DATE WORK COMPLETE (YY/MM/DD) 5/07/21

MEASUREMENT RECORDED IN: METRIC ☑ IMPERIAL ☐

Well Owner and Location Information:

FIRST NAME	LAST NAME	ADDRESS OF WELL LOCATION (STREET NAME AND NUMBER)
John	Smith	62 Baseline Road

TOWNSHIP	LOT	CONCESSION	COUNTY/ DIST/ MUNIC	CITY/ TOWN/ VILLAGE
Zip	5	5	Hastings	Smallville

NAD 83 | 17 | 738777 | 4938200
ZONE EASTING NORTHING

Geo - Log:

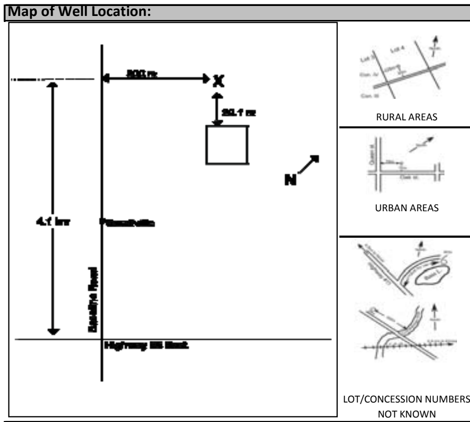
COLOURS: WHITE, GREY, BLUE, GREEN, YELLOW, BROWN, RED, BLACK

MATERIALS: FILL, MUCK, PEAT, CLAY, SILT, GRAVEL, STONES, BOULDERS, TOP SOIL, LIMESTONE, FINE SAND, MEDIUM SAND, COARSE SAND, DOLOMITE, SHALE, SANDSTONE, SLATE, QUARTZITE, GRANITE, GREENSTONE

GENERAL DESPCRIPTION: LOOSE, POROUS, DENSE, PACKED, CEMENTED, LAYERED, SOFT, HARD, PREVIOUSLY DUG OR BORED, PREVIOUSLY DRILLED, WOOD FRAGMENTS

GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GEN. DESCRIPTION	COMMENTS	DEPTH (m/ft) FROM	TO
Brown	Top Soil	/	Loose	/	0	0.45
Grey	Clay	/	Layered	/	0.45	7.62
Brown	Coarse Sand	Stones	Porous	Lost Circulation	7.62	9.75
Grey	Limestone	Gravel	Layered	/	9.75	10.36
Grey	Limestone	/	Hard	/	10.36	12.8
Red/Green	Limestone	/	Soft	/	12.8	13.1
Grey	Limestone	/	Hard	/	13.1	16.76

Map of Well Location:



Results of Well Yield Testing:

After test of well yield, ☐Clear and sand free ☐Other

IF PUMPING DISCONTINUED, GIVE REASON

PUMP INTAKE SET AT (m/ft) 15.24

PUMPING RATE (l/min / GPM) 26.5

DURATION OF PUMPING 1 HRS + 0 MIN

FINAL WATER LEVEL END OF PUMPING (m/ft) 11.3

DISINFECTED: ☑YES ☐NO

DRAWDOWN (cm/in) TIME (MIN.)	WATER LEVEL	RECOVERY (cm/in) TIME (MIN.)	WATER LEVEL
STATIC LEVEL	2.4		
1	3.04	1	11
2	3.7	2	10.36
3	4.9	3	8.5
4	5.5	4	7.9
5	6.7	5	7.01
10	10.9	10	6.7
15	11.27	15	5.5
20	11.27	20	3.96
25	11.27	25	3.04
30	11.27	30	2.4
40	11.27	40	2.4
50	11.27	50	2.4
60	11.27	60	2.4

Construction Record - Screen

OUTSIDE DIAM. (cm/ in)	MATERIAL	SLOT #	DEPTH (m/ft) FROM	TO

Water Details:

WATER FOUND AT DEPTH	KIND OF WATER
12.8 (m/ft) ☐GAS	FRESH/UNTESTED/OTHER
______(m/ft) ☐GAS	FRESH/UNFRESH/OTHER
______(m/ft) ☐GAS	FRESH/UNFRESH/OTHER

Hole Diameter:

DEPTH (m/ft) FROM	TO	DIAM. (cm/in)
0	11	2.54
11	16.76	15.56

Construction Record - Casing:

INSIDE DIAM. (cm/ in)	OPEN HOLE OR MATERIAL	WALL THICK-NESS	DEPTH (m/ft) FROM	TO
15.88	Steel	0.477	0	11

Annular Space:

DEPTH (m/ft) FROM	TO	MATERAL	NO. BAGS PLACED
0	11	Bentonite	3

WELL OWNER'S INFO PACKAGE DELIVERED YES x NO______

DATE PACKAGE DELIVERED (YY/MM/DD) 05 07/ 21

LENGTHS OF CASING BROUGHT TO JOB SITE (m/ ft) 6 6 6 10 6 6 3

LENGTHS OF CASING INSTALLED IN WELL (m/ft) 6 6

Figure 13-1: Sample Log Book Entry

Single Well Record Information

A well record is required to be completed after the following activities:

- New well construction
- Making an alteration to a well (other than a minor alteration or pump installation including any alterations necessary to accommodate the pumping equipment)
- Abandoning (sealing and plugging) a well

The person constructing the well must complete the well record for new well construction and alterations.

The person abandoning the well must complete the well record for the abandonment of a well.

The person abandoning the well is considered to be:

- The person constructing a new well (i.e. a well technician or an individual who is exempt from licensing and works at the construction of a well) that is discontinued before the completion of the well's structural stage must immediately abandon the well.
- The well purchaser for a dry well that must be immediately abandoned.
- The well owner for a well that must be immediately abandoned because it:
  - is not in use or being maintained for future use;
  - is producing water that is mineralized or not potable;
  - contains natural gas or other gas;
  - permits the movement of materials including natural gas and contaminants; or
  - is constructed in contravention of the **Wells Regulation** requirements for location, methods, materials or standards and measures taken to rectify the problem have failed.

For further information on the person abandoning the well and the responsibilities of the person abandoning the well please see Chapter 14: Abandonment: *When to Plug and Seal Wells* and Chapter 15: *Abandonment: How to Plug and Seal Wells.*

Considerations When Completing the Well Record

The instructions for completing the well record after construction are found on the back of the form. The well record includes instructions on how to observe and report the formation's texture (grain size), colour, hardness and other observations in general terms. See Figure 13-2 to Figure 13-9 for further information.

The person altering or abandoning an existing well must, as a minimum, complete the mandatory (not shaded; common fields) sections of the well record as stated in the instructions found on the back of the well record. It is not necessary to complete a well record when installing a pump or performing a minor alteration, unless the well tag is broken, defaced, illegible or otherwise unusable (see “Broken, Defaced, Illegible or Unusable Well Tags,” on page 30 of this chapter).

Additional well record forms must be used if more information is required (see explanation of Page Number box in the Completing the Well Record section on the next page). Unless specified, all depths must be expressed from the ground surface at the time of construction.

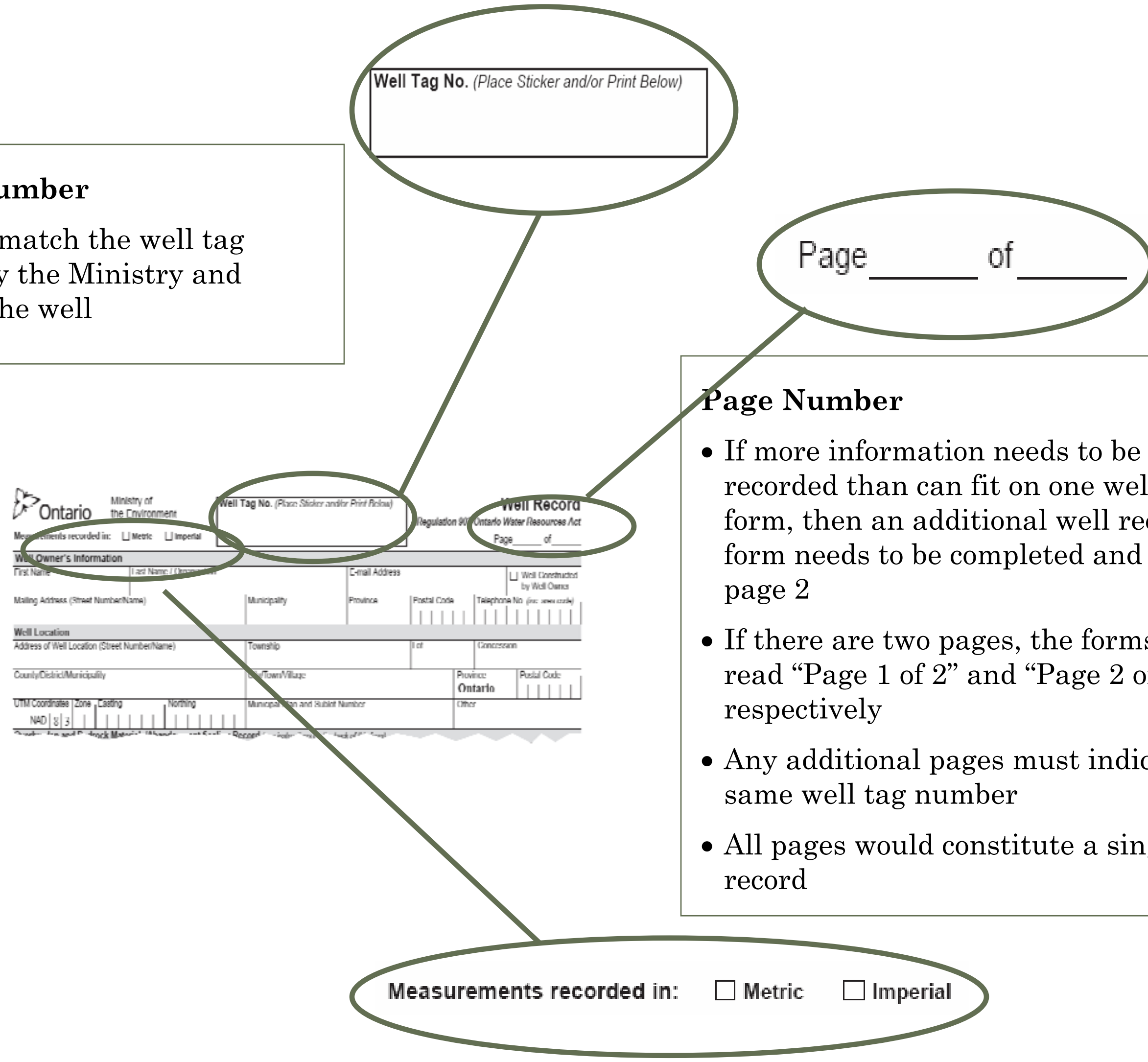
For the purposes of this manual, which only applies to water supply wells, filling out information on two or more wells on one well record is not permitted. There are special situations for test holes and dewatering wells where one cluster well record can be completed for two or more wells but this is not covered in this manual.

If plugging and sealing a well immediately after installing the well due to a well being discontinued, then two separate well record forms that make one well record must be filled out: the first form (page 1 of 2) for the construction and the second form (page 2 of 2) for the plugging and sealing of the well.

Completing the Well Record

Figures 13-2 to 13-9 provide an explanation of how to complete a well record

Figure 13-2: General Information



Well Tag Number

- This must match the well tag provided by the Ministry and affixed to the well

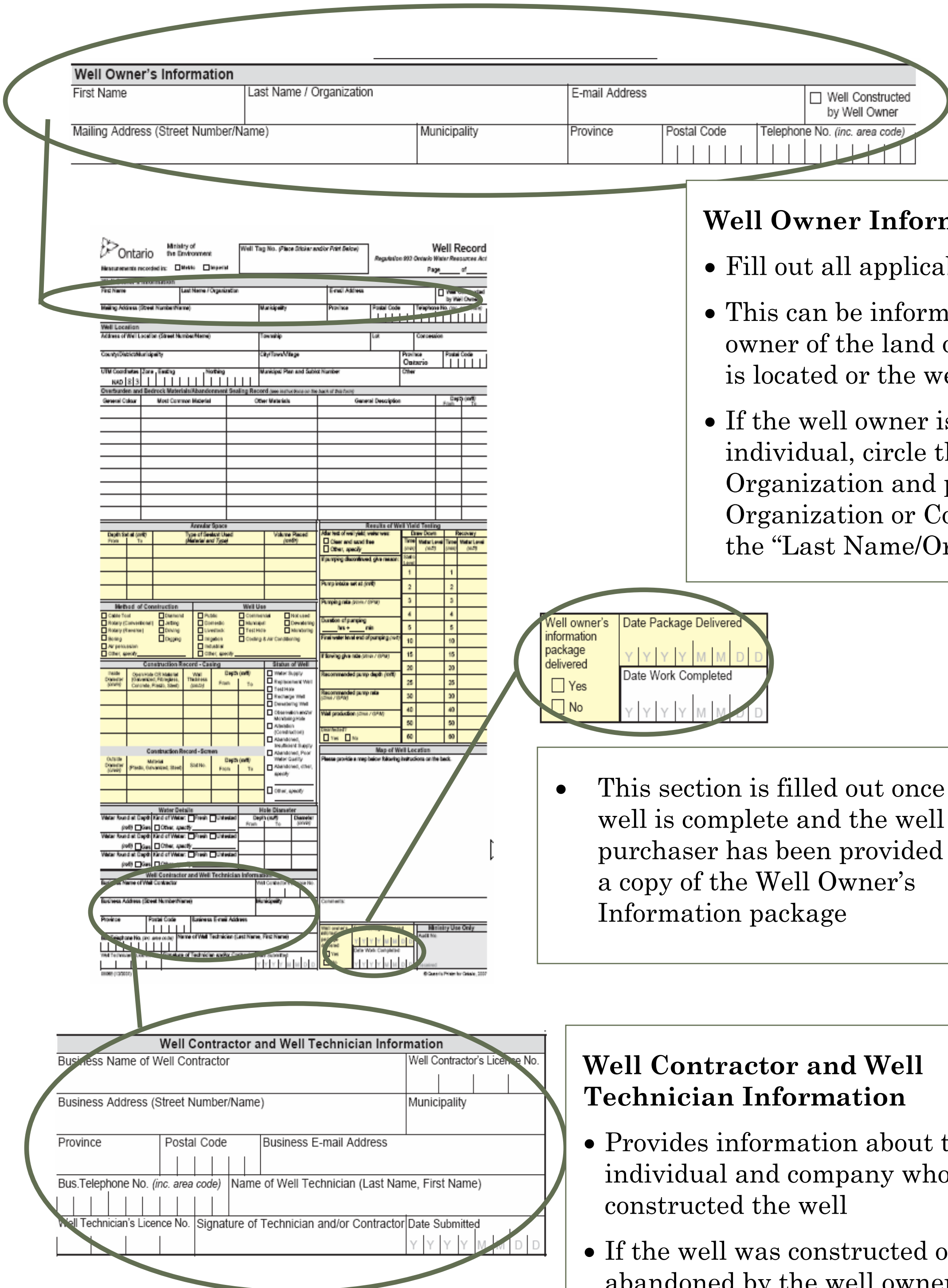
Page Number

- If more information needs to be recorded than can fit on one well record form, then an additional well record form needs to be completed and called page 2
- If there are two pages, the forms would read "Page 1 of 2" and "Page 2 of 2", respectively
- Any additional pages must indicate the same well tag number
- All pages would constitute a single well record

Measurements

- Record in the units specified in the well record sections
- Unit system chosen must be used consistently on the well record
- Do not mix metric and imperial units
- Check the applicable box

FIGURE 13-3: WELL OWNER INFORMATION



Well Owner Information

- Fill out all applicable sections
- This can be information on the owner of the land on which the well is located or the well purchaser
- If the well owner is not an individual, circle the word Organization and print the Organization or Company name in the "Last Name/Organization" field

- This section is filled out once the well is complete and the well purchaser has been provided with a copy of the Well Owner's Information package

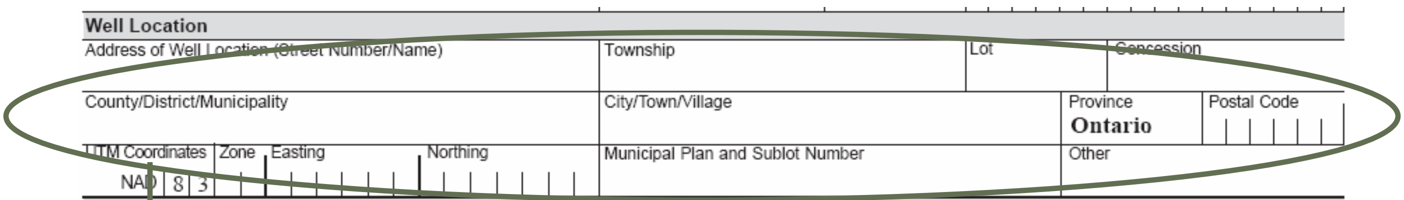
Well Contractor and Well Technician Information

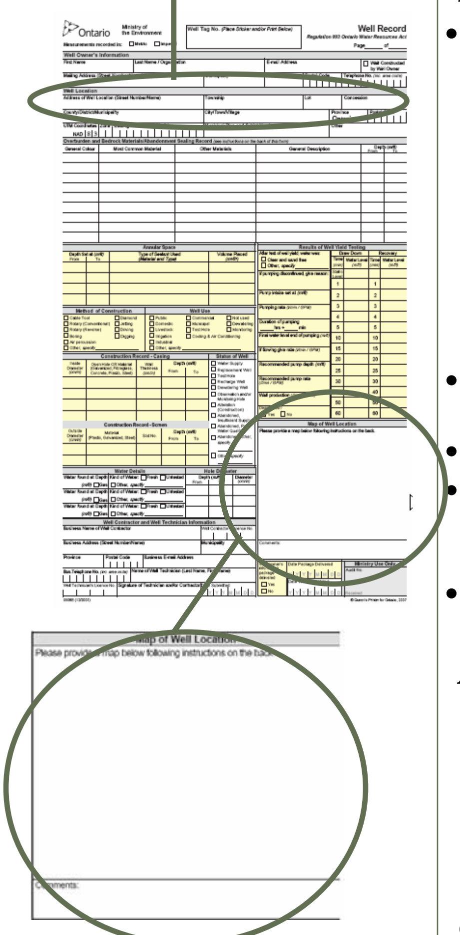
- Provides information about the individual and company who constructed the well
- If the well was constructed or abandoned by the well owner, check the appropriate box in the "Well Owner's Information" section and do not complete this section

FIGURE 13-4: WELL LOCATION

Well Location

- Street number/name, city/town/village must be provided if available
- Original geographic township, concession and lot must be reported if the well is located in an area where such information exists
- The fire locator number may also be recorded in the "Other" box
- UTM Coordinates must be recorded using a GPS unit
- Municipal plan and sublot numbers may be provided if available
- Current county or district/amalgamated municipality or township, if reported, should be entered under "County/District/Municipality." For example in the County of Frontenac/Township of South Frontenac, the Township of South Frontenac is the amalgamated township

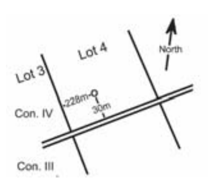




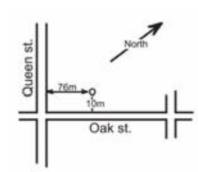
Map of Well Location

- Provide a map showing all property boundaries. At least two measurements sufficient to locate the well in relation to fixed points should be provided. For example:
  - In rural areas, one distance should be taken from a road and the other from either a road or a township lot line (example A, below)
  - In a village, town or city, both distances should be taken from named streets (example B)
  - In areas where it is difficult to obtain lot and concession numbers, sufficient information should be supplied in the diagram so that the well can be related to a known unit such as a main highway, railway, or municipality (examples C and D)
- Detailed drawings can be provided as attachments on paper no larger than the size of the well record (8.5″by 14″)
- Include a North arrow
- The "Comment" box may be used to record any additional information such as the elevation of the well. It is also an appropriate place on the record to state whether or not hydrofracturing or blasting were done at the time of construction
- The "Comment" box is also an appropriate place to reference the original well tag when a well tag is replaced and original well record number for an alteration

A



B



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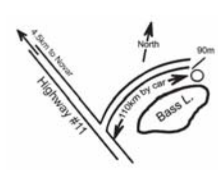
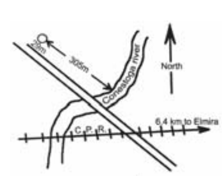


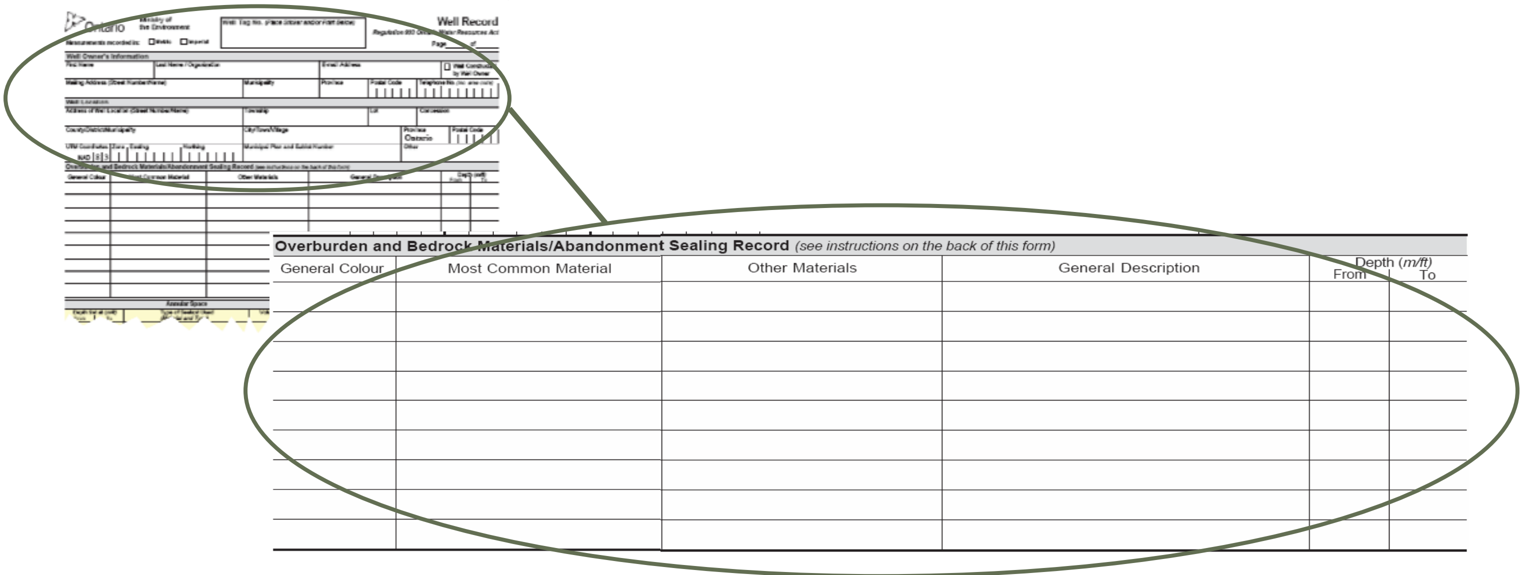
D



Best Management Practice – Compiling Details about Hydrofracturing or Blasting Techniques

The person should explain if and how these operations were performed on a separate sheet. Attach the sheet to the well record and make copies of the attachment to go with each copy of the well record.

FIGURE 13-5: OVERBURDEN AND BEDROCK MATERIALS / ABANDONMENT SEALING RECORD



Overburden and Bedrock Materials/ Abandonment Sealing Record

- If plugging and sealing a well, then the abandonment details must be recorded in this section.
  - Indicate the type of sealant (i.e. abandonment barrier) used in the "General Description" column and complete the "Depth" column
- If a well is discontinued before its structural stage has been completed, the well must be immediately abandoned (plugged and sealed). Two separate well record forms that make one well record must be completed. The first form (page 1 of 2) must be completed for the construction and the second form (page 2 of 2) for the plugging and sealing of the well
- If constructing a well:
  - For each formation encountered during construction, words from the lists provided on the back of the well record that best describe the formation on the basis of general colour, most common material, other materials and general description of the formation must be chosen
  - Instructions are found on the back of the well record and shown below

General Colours		Materials					General Descriptions		
White	Yellow	Fill	Silt	Top Soil	Coarse Sand	Slate	Loose	Cemented	Previously Dug or Bored
Grey	Brown	Muck	Gravel	Limestone	Dolomite	Quartzite	Porous	Layered	Previously Drilled
Blue	Red	Peat	Stones	Fine Sand	Shale	Granite	Dense	Soft	Wood Fragments
Green	Black	Clay	Boulders	Medium Sand	Sandstone	Greenstone	Packed	Hard	

Clay: Composed of very fine particles. Forms dense hard lumps or clods when dry and a very elastic putty-like mass when wet. It can be rolled between fingers to form a long, flexible ribbon.

Silt: Grain size, midway between sand and clay. It may form clods which, when broken, feel soft and floury. When moist, it will form a cast that can be handled freely without breaking. Rolled between thumb and finger, it will not "ribbon" but will give a broken appearance.

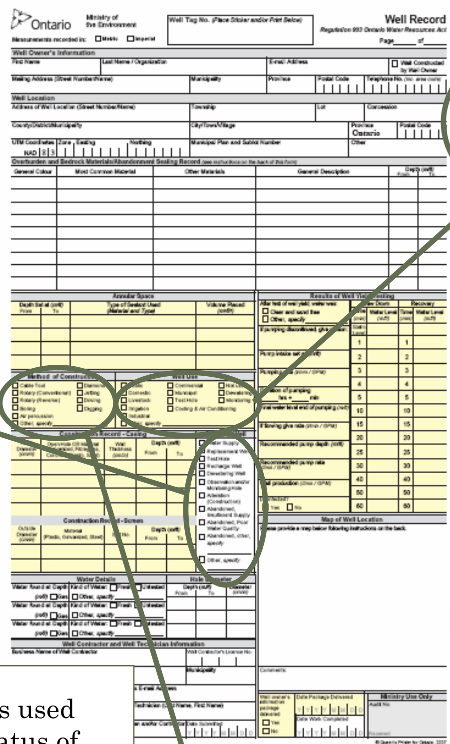
Sand: Grains are loose and granular and may be seen and felt readily. Squeezed in the hand when dry, it falls apart when the pressure is released. Squeezed when moist, it will form a cast that will crumble when touched. Should be listed as fine, medium or coarse.

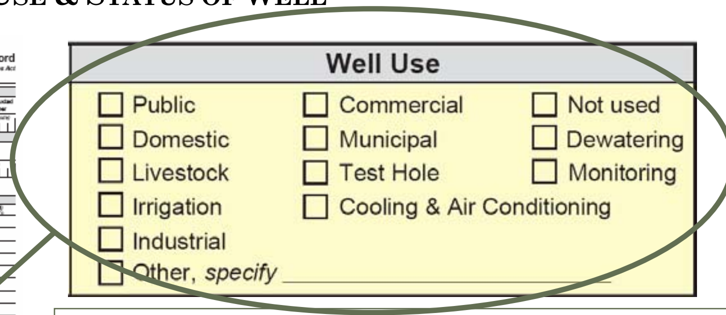
Gravel: Rock fragments greater than 0.3 cm in diameter.

  - Examples of materials provided below as well as on the back of the well record

General Colours	Most Common Material	Other Materials	General Descriptions	Depth	
				From	To
Brown	Top Soil			0	0.6
Grey Blue	Coarse Sand Clay	Gravel, Silt Silt, Stones	Loose, Wood Fragments Dense	0.6 13.0	13.0 25.0
Brown	Fine Sand	Clay		25.0	31.0
Grey	Limestone		Porous, Hard	31.0	34.0

FIGURE 13-6: METHOD OF CONSTRUCTION, WELL USE & STATUS OF WELL

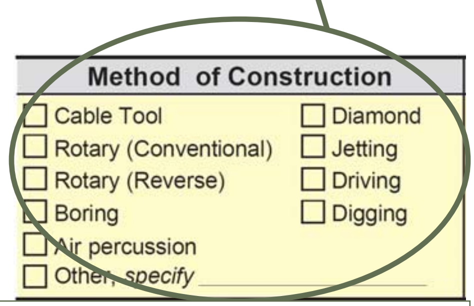




Status of Well section is used section to identify the status of the well at the time of completion. Check all boxes that apply

Water Supply Wells includes public, domestic, livestock, irrigation, industrial, commercial, municipal and cooling & air conditioning

Replacement Wells includes all wells listed under the 'well use section' except "Not used"



Method of Construction

Identify the construction method used. There could be more than one (e.g. rotary conventional and air percussion). Use the "Other" box and add the type of method, such as barber drilling or air rotary, if it is not listed.

Well Use

"Well use" means the intended purpose at the time of construction:

Public – e.g. school, religious organization, town hall, recreation centre, campground, trailer park

Domestic – for private residential homes

Livestock – used for farms and feed lots

Irrigation – used for agricultural activities, golf courses and greenhouses

Industrial – factories using water for industrial purposes but not incorporation into a food product or mineral exploration

Commercial – e.g. car wash, snow making, restaurant, bottled water or other beverage making

Municipal – water supply for cities and towns

Test hole – a well that is made to test or to obtain information in respect of groundwater or an aquifer and is not intended as a source of water for agriculture or human consumption

Cooling & Air Conditioning – e.g. an open or closed loop earth energy system (heat pump)

Not used – constructed for some purpose, not being used and will be maintained for future use. A second box must be checked to indicate the intended use

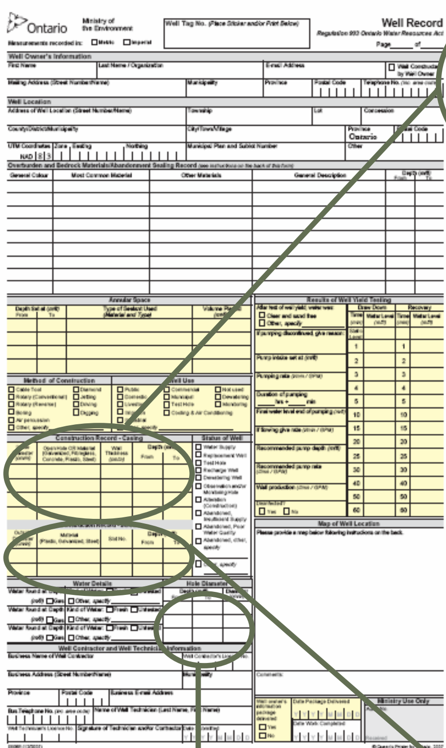
Dewatering – a well that is not used or intended for use as a source of water for agriculture or human consumption and that is made to lower or control the level of groundwater in the area of the well, or to remove materials that may be in the groundwater

Monitoring – a well that is made to test or to obtain information in respect of groundwater or an aquifer and is not intended as a source of water for agriculture or human consumption

Other – e.g. communal such as water supply that serves a small rural sub-division

In the situation where a test hole or dewatering well for a subdivision is then used as a private water supply, both boxes that apply must be checked off (original and future purposes).

FIGURE 13-7: CONSTRUCTION RECORD AND HOLE DIAMETER



Construction Record - Casing				
Inside Diameter (cm/in)	Open Hole OR Material (Galvanized, Fibreglass, Concrete, Plastic, Steel)	Wall Thickness (cm/in)	Depth (m/ft)	
			From	To

Construction Record - Casing

- Material means type of manufactured material used to make the casing
- Report a well interval without casing as open hole
- Wall thickness means minimum or nominal wall thickness
- A new line should be filled in for every change in casing (e.g. material, inside diameter or wall thickness) or open hole diameter
- All depths must be expressed from the ground surface at the time of construction. The amount of casing expressed above the ground surface should be expressed with "+". For example a contractor installs casing +0.6 m above the ground surface and extends the casing to 7 m below the ground surface
- Record joint and packer locations from ground surface (see best management practice below)

Hole Diameter		
Depth (m/ft)		Diameter (cm/in)
From	To	

Construction Record - Screen				
Outside Diameter (cm/in)	Material (Plastic, Galvanized, Steel)	Slot No.	Depth (m/ft)	
			From	To

Construction Record - Screen

- Material can also include sand pre-pack screens and unsealed concrete tiles or other material installed in a well to filter out particulate matter
- Record slot number as provided by manufacturer
- Depth includes top of riser pipe, if applicable
- All depths must be expressed from the top of the ground surface at the time of construction

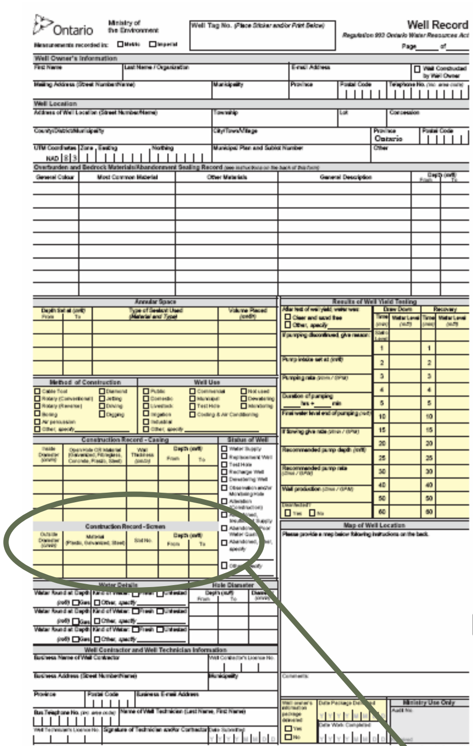
Hole Diameter

- Record the diameter and depth of the borehole using the measurement unit system chosen at the top of the well record (metric or imperial)
- Record the depth of borehole relative to the ground surface

Best Management Practice- Recording Joint and Packer Locations

Record casing joint and packer locations (depths) from ground surface in the "Construction Record – Casing" box of the Well Record.

FIGURE 13-8: ANNULAR SPACE



Annular Space

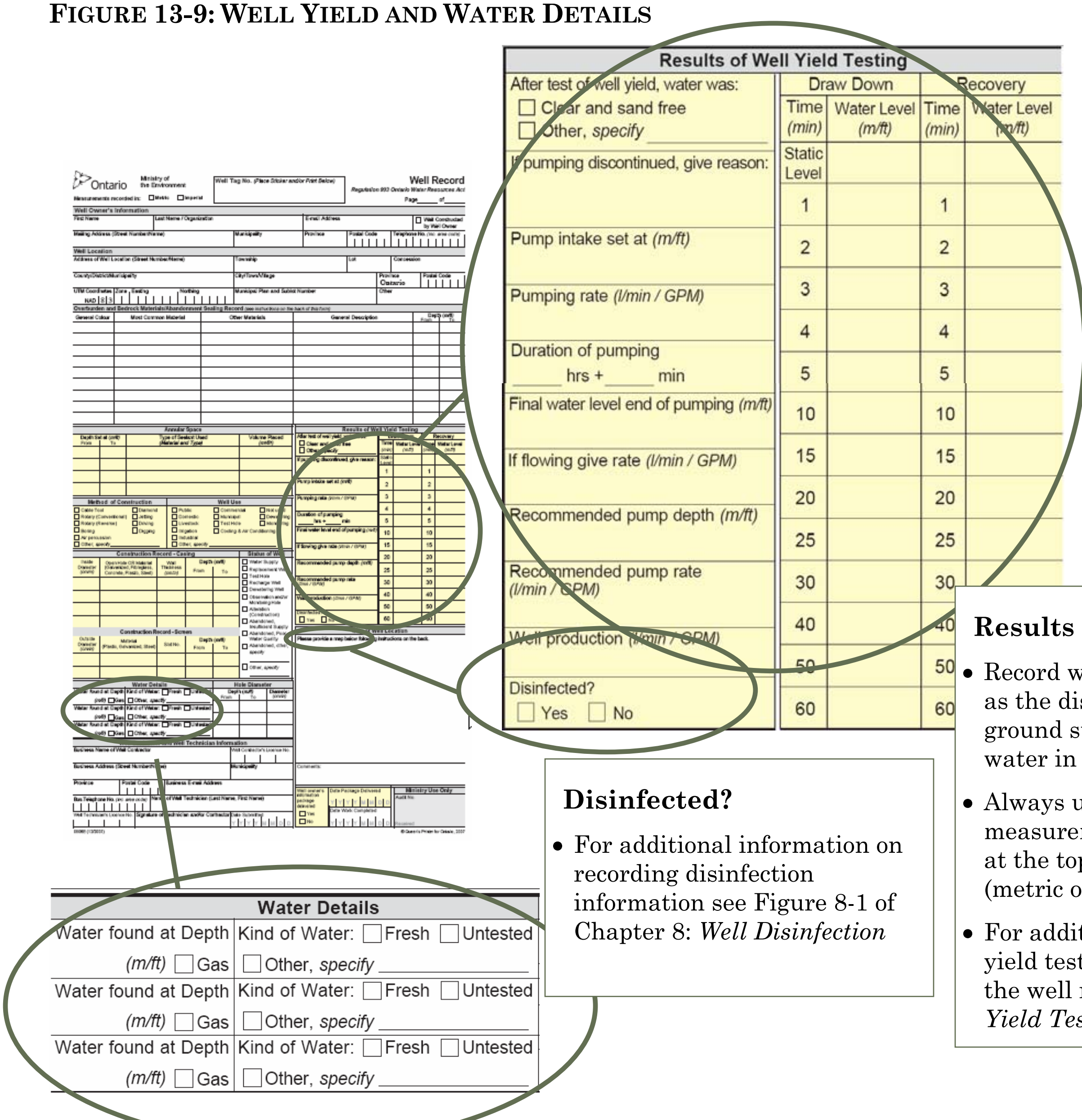
- Record 'depth set at' relative to the ground surface
- Record the type of suitable sealant installed in the annular space
- Record 'depth set at' and 'volume placed' in the measurement units indicated at the top of the well record (metric or imperial)
- The volumes of sealant placed must be shown as either m³ or ft³
- Calculate 'volume placed' (see Chapter 6: *Annular Space and Sealing*, Calculating Amount of Material Required section)
- Type of Sealant Used:
  - "Material" means sodium bentonite, cement, concrete and other suitable sealants
  - "Type" means trademark name of the product

Annular Space			
Depth Set at (*m/ft*)		Type of Sealant Used (*Material and Type*)	Volume Placed (*m³/ft³*)
From	To		

Best Management Practice – Recording all Material Installed in Annular Space

Within the annular space box, also record where any clean washed sand or gravel has been installed in the well's annular space (e.g. around well screen).

FIGURE 13-9: WELL YIELD AND WATER DETAILS



Disinfected?

- For additional information on recording disinfection information see Figure 8-1 of Chapter 8: *Well Disinfection*

Results of Well Yield Testing

- Record water level measurements as the distance between the ground surface and the top of the water in the well
- Always use the same measurement unit system chosen at the top of the well record (metric or imperial)
- For additional information on yield testing and this section of the well record see Chapter 10: *Yield Test*

Water Details

- Record the depth(s) at which water and naturally occurring or other gas is found. Record the distance from the ground surface to the water bearing formation(s) or horizon(s) (i.e. where water is found).
- Always use the same measurement unit system chosen at the top of the well record (metric or imperial)
- Check the correct box for the type of water found:
  - "Fresh water" means that there are no taste, odour or colour issues with the water in the field (Use field testing equipment instead of tasting well water to avoid drinking potentially contaminated or non-potable water)
  - "Other" could include mineralized water (see definition in Chapter 2: *Definitions & Clarifications,* Table 2-1). When other is checked, the issue must be specified.
- If gas is encountered, contact the Ministry of the Environment (see "Notifications" section on page 30)

Units of Measurement

The well record allows for the use of imperial units or metric units. A check box, found at the top of the well record, allows for identification of metric or imperial units. The unit system chosen must be used consistently throughout the well record.

Well Record Delivery

New Well Construction

A completed well record must be delivered by the person constructing the well to the well purchaser and land owner within 14 days after the date on which the well's structural stage is complete.

A completed well record must be forwarded by the person constructing the well to the ministry at the Water Well Help Desk, Ministry of the Environment, 125 Resources Road, Toronto Ontario M9P 3V6 within 30 days after the date on which the well's structural stage is complete.

A completed well record must be kept by the person constructing the well for at least two years.

Best Management Practice – Keeping Well Record

Any well record for construction, alteration or abandonment should be kept longer than the 2 years required as this assists the industry in responding to future enquiries regarding the well or other wells in the area.

Alterations

When an alteration to a well requires the completion of a well record, a copy of the completed well record must be delivered by the person constructing (altering) the well to the well purchaser and land owner within 14 days after the date on which the well's structural stage is complete and a copy must be retained for at least 2 years.

A completed well record must be forwarded to the Ministry at the Water Well Help Desk, Ministry of the Environment, 125 Resources Road, Toronto Ontario M9P 3V6 within 30 days after the date on which the well's structural stage is complete.

Further information on the well's structural stage and minor alteration can be found in Chapter 2: *Definitions & Clarifications*, "Table 2-1".

ABANDONMENT

A completed well record must be delivered by the person abandoning the well (often the well owner) to the owner of the land on which the well is situated within 14 days after the date on which the well construction equipment is removed from the site.

A completed well record must be forwarded by the person abandoning the well (often the well owner) to the Ministry at the Water Well Help Desk; Ministry of the Environment, 125 Resources Road, Toronto Ontario M9P 3V6 within 30 days after the well construction equipment is removed from the site.

Examples of well construction equipment include the following: grout pump and tremie pipe(s), casing removal equipment such as a cutter or torch, drilling rig, boring rig, excavator, pump truck, drive point equipment.

Best Management Practice – Keeping Well Record

Any well record for construction, alteration or abandonment should be kept longer than the 2 years required as this assists the industry in responding to future enquiries regarding the well or other wells in the area.

Best Management Practice – Extra Well Record Copies

If the well purchaser and owner of the land are different, the person completing the well record should provide a copy of the well record to both the well purchaser and the owner of the land as well as the ministry. The person completing the well record should certify any extra copies of the well record before providing them to either the owner of the land or the well purchaser.

Best Management Practice –Make Extra Copies of the Well Record

It is important that the well owner make additional copies of the well record and keep the copies in a location where they can be easily found, such as one or more of the following:

- Beside the pumping equipment
- With mortgage papers
- Land property survey
- In a safety deposit box

It is also important to provide all well records for wells, including the abandoned wells, when the property is transferred to a new owner. The new well owner will then have knowledge of the location and status of the wells on the property to prevent:

- Well damage from any new excavations or building on the property; and
- Well contamination from any new source of contaminants constructed near a well.

WELL TAGS

Before the structural stage of a new cased well is completed, the person constructing the well must affix a well tag, issued by the Ministry, permanently to the outside of the casing or to a permanent structure associated with the well. The affixed tag must be visible and must not be obstructed by the well cap or other well components or by equipment associated with the well.

During alterations to a cased well with a well tag, the well tag must be safeguarded and, if removed, it must be re-affixed permanently to the outside of the casing or to a permanent structure associated with the well before completing the alteration.

If the work or repair is an alteration to a well, other than a minor alteration, and a well tag is not present, the person constructing the well must obtain and affix a Ministry issued well tag permanently to the outside of the casing or to a permanent structure associated with the well. The affixed tag must be visible and must not be obstructed by the well cap or other well components or by equipment associated with the well.

The well tag sticker for the new tag must be placed on the well record form completed for the alteration. As an alternative, the person constructing the well must copy and record the alphanumeric code from the well tag onto the well record.

The **Wells Regulation** defines a minor alteration as any of the following:

- Routine repair or maintenance
- The installation of monitoring, sampling or testing equipment used to test the yield of the well or the aquifer
- The installation of a pump in a test hole
- The installation of a well cap or watertight well cover

Best Management Practice – Completing Well Record When Affixing a Well Tag

A well record should be completed and submitted to ensure that the well in the field is linked to the well record when a well tag is affixed as a result of installing a pump and associated pumping equipment or altering the well to accommodate the pump or associated pumping equipment.

FIGURE 13-10: SAMPLE WELL TAG

See the "Broken, Defaced, Illegible or Unusable Well Tags" section on page 30 of this chapter for further requirements on replacing a well tag when conducting a minor alteration to a well.

How to Attach the Well Tag to the Casing

If the well tag is to be permanently affixed to the well casing, it is preferable to use a stainless steel strap. Strapping and welding rods made of stainless steel are essential to prevent corrosion. If strapping is not feasible, the tag may be tack welded into place. The tag can also be lag bolted or screwed into concrete.

If a strap is used, it should be placed through the slots in the tag, wrapped around the casing and crimped tight with a strapping tool. If tac welding, the four corners of the tag should be welded to the casing using stainless steel welding rods. If lagging or screwing is the selected method, the drill holes should not fully penetrate through the well casing. This would compromise the casing integrity.

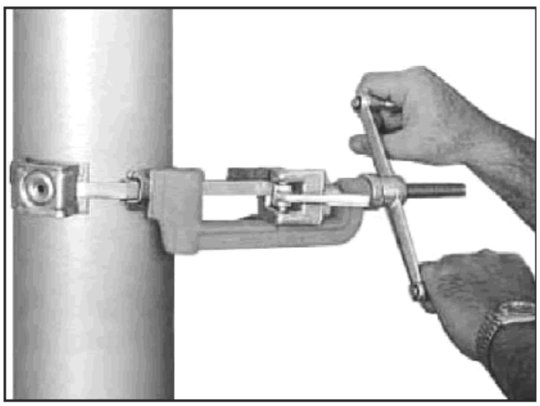


Figure 13-11: Attaching the Well Tag to the Casing

The diagram shows a strapping tool used to affix metal straps and a well tag to a well. See description in the above text. Figure 13-12 shows the well tag affixed to the well using the metal strapping.

Attaching Well Tags in Various Scenarios

Scenario # 1: The Casing of the Well Extends Above Grade and the Pump is not Positioned Over the Casing

This scenario would include wells with a submersible pump or jet pump. The tag is affixed around the casing with a stainless steel strap (see Figure 13-11 for strapping tool) or, if strapping is not possible, the tag is welded into place with stainless steel rods or lag bolted/screwed into the concrete casing (Figure 13-13.). In the case of a driven point well, when the casing is not higher than 40 cm above the ground level, a highly visible marker is also required to be placed near the well (see Figure 13- 14.).

Figure 13-12: Example of Properly Attached Well Tag

Figure 13-13: Threaded Screws attaching Well Tag to Concrete Casing

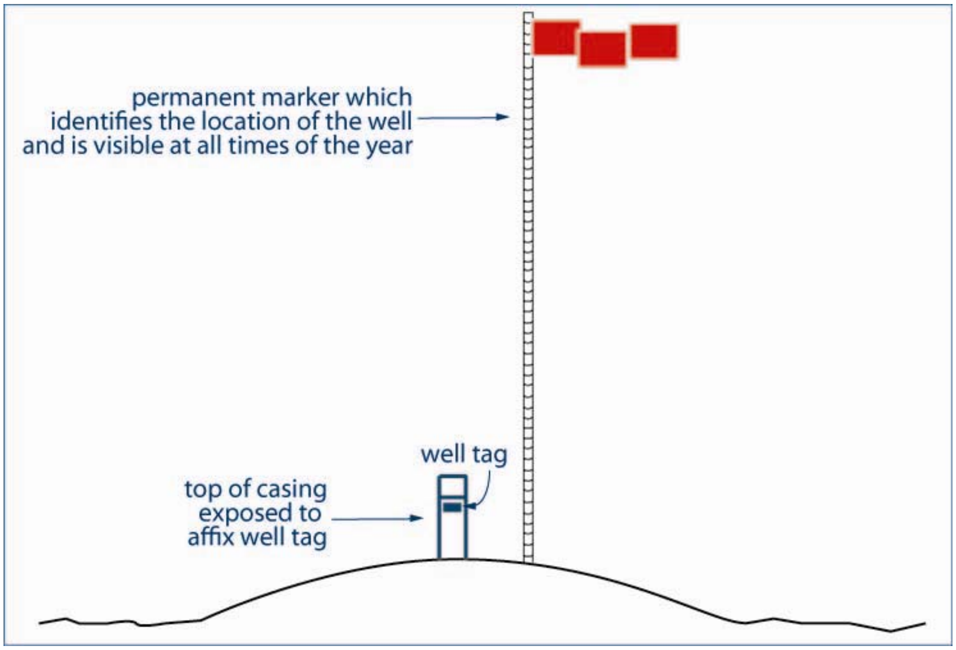


FIGURE 13- 14: WELL TAG AFFIXED TO A DRIVEN POINT WELL

SCENARIO # 2: THE CASING STICKS UP AND THE PUMP IS LOCATED DIRECTLY OVER THE CASING

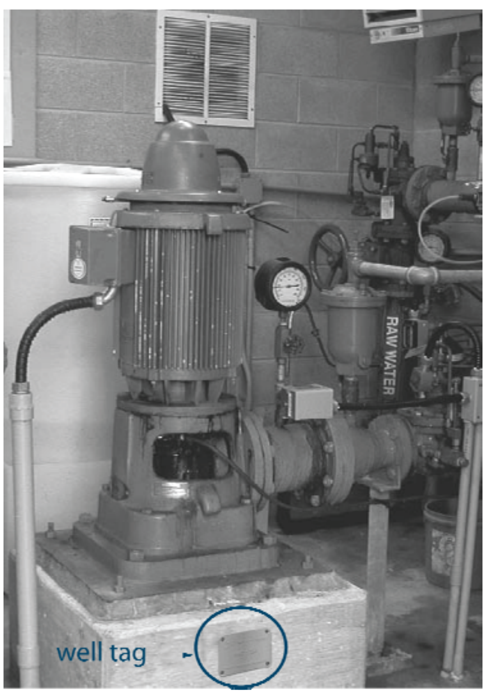


FIGURE 13-15: WELL TAG ON EQUIPMENT ASSOCIATED WITH THE WELL AS CLOSE AS POSSIBLE TO THE CASING

This scenario would include wells with a vertical turbine pump, or another type of pump positioned directly over the casing. Some methods of affixing the well tag include setting/screwing or lag bolting the well tag into the concrete well slab as close as possible to the casing. The well tag must remain visible and protected from wear and tear.

Scenario # 3: The Pump and Casing Are Located in a Pump House

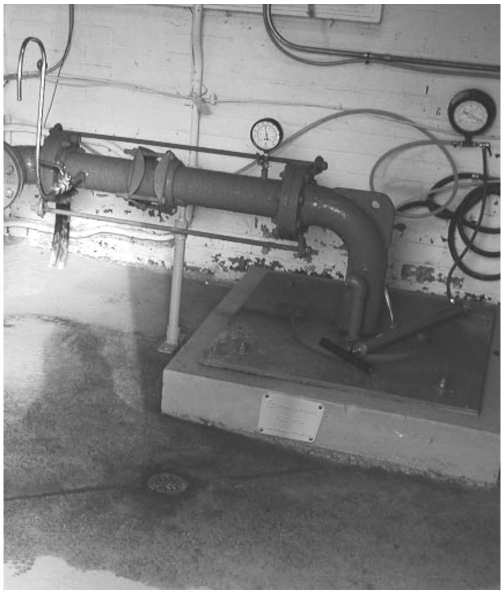


Figure 13-16: Inside Pump House with Visible Well Tag on Associated Well Equipment

The presence of a well house does not affect the placement of the well tag. The tag location depends on whether the pump is positioned directly over or offset from the casing. The directions in Scenario #1 or #2 should be followed, whichever is appropriate. In addition, the well owner is encouraged to post a sign on the outside of the pump house, either next to the door or on the door, indicating the well tag number.

Broken, Defaced, Illegible or Unusable Well Tags

The **Wells Regulation** exempts a person from completing a well record and affixing a well tag on a well for a minor alteration unless the well tag is broken, defaced, illegible or otherwise unusable. In these situations, the person doing the alteration, including a minor alteration, must:

- Remove the well tag and return it to the Director,
- Obtain a new well tag from the Ministry and, before the alteration is completed, affix the well tag permanently to the outside of the casing or to a permanent structure associated with the well, at a point where the well tag will be visible and will not be obstructed by the well cap, by other components of the well or by equipment associated with the well, and
- Within 30 days after the new well tag is affixed to the casing, complete a well record with respect to the replacement of the well tag and forward a copy of the well record and the original well tag to the Director.

Best Management Practice – Referencing the Original Well Tag Number

When a well tag is replaced, the new well record for the replacement of a well tag should reference the original well tag number if it is available.

Best Management Practice – Completing Well Record When Replacing a Damaged Well Tag

Provide as much information as the Ministry requests on the well record form and provide the well record to the well owner and well purchaser when filling out a well record for a minor alteration (e.g. replacing a damaged well tag).

FIGURE 13-17: BEFORE – WELL TAG MUST BE REPLACED

FIGURE 13-18: AFTER - WELL TAG REPLACED

Figure 13-17 and Figure 13-18 show the before and after of a broken well tag that was replaced when a minor alteration (e.g. well cap removal) was made to the well. In this case the well cap and conduit pipe were also upgraded to remove a pathway for foreign materials to enter the well

NOTIFICATIONS

Ontario

The **Wells regulation** requires:

- Where a well is constructed and mineralized water is encountered, the person constructing the well must immediately notify the well purchaser and the owner of the land on which the well is located of the condition (For further information on mineralized water see Chapter 2: *Definitions & Clarifications*, "Table 2-1").
- Where a well is constructed and natural gas is encountered, the person constructing the well must immediately notify the well purchaser, the owner of the land on which the well is located and the Director of the condition (for further information on natural gas see Chapter 2: *Definitions & Clarifications*, "Table 2-2").
- Unless the well purchaser otherwise directs, on the day that the structural stage is complete, the person constructing the well (other than a minor alteration) must:
  - Deliver an information package from the ministry to the well purchaser,
  - Provide a water sample, of at least one litre, to the well purchaser for visual examination, and
  - Measure the depth of the well in the presence of the well purchaser.
- Unless the well purchaser otherwise directs, on the day that a pump (which includes associated equipment) is replaced in an existing well, the person installing the pump must:
  - Deliver an information package from the ministry to the well purchaser.
- Before the well is used as a source of water for human consumption, the person who disinfects and tests the well water for free chorine residual must provide the well purchaser with a written record of the test results (see Chapter 8: *Well Disinfection*).

If a naturally occurring gas associated with the groundwater, soil or bedrock is encountered, the Ministry should be contacted through the Spills Action Centre at 1-800-268-6060. The Spills Action Centre alerts the various Ministry branches including the Director. In addition, the local fire department and local health unit should be contacted.

For more information about water quality and contamination issues, see the section titled: "Encountering Contamination and Water Quality Problems," in of Chapter 5: *Constructing & Casing the Well*.

Best Management Practice – Informing the Well Owner of Nearby Sources of Contamination

The well owner should be immediately informed if it becomes known that the existing well is located on or near a source of contamination (see Chapter 4: *Siting the Well*).

Best Management Practice – Reporting Detection of Colour, Odour or Other Problems

In addition to the requirement to record observed water quality problems on the well record, detection of colour, odour or other problems with the well water should be reported to the well purchaser and land owner, and the observations should be recorded on the well record. To protect all parties, a written copy of the notification of water problems should be provided to the well purchaser and land owner. A copy of the written notification should also be retained.

It is important to use field testing equipment instead of tasting well water to avoid drinking potentially contaminated or non-potable water.

Best Management Practice – Educating the Well Owner

The well owner has responsibilities under the **Wells Regulation** for every well on his/her property. In some cases, this may be the well owner's first well and the well owner may not know how to maintain the well and protect the water supply. The person constructing the well should explain the following to the well owner using plain language:

- How to care for a well
- The requirements for maintaining and abandoning the well
- The construction details, water quantity, water quality and other sections of the well record (for new wells or altered wells)
- The next steps such as pump installation (for new wells)
- The importance of reviewing the Ministry information package about wells
- The importance of keeping the well accessible for future maintenance
- Any other information, including the **Wells Regulation** and relevant internet websites

TOOLS

FIGURE 13-19: EXAMPLE OF THE FRONT PAGE OF A LOG

LOG

NAME OF WELL TECHNICIAN ______________________________

DATE WORK COMPLETE (YY/MM/DD) ______________________________

MEASUREMENT RECORDED IN:

METRIC ☐ IMPERIAL ☐

Well Owner and Location Information:

FIRST NAME LAST NAME ADDRESS OF WELL LOCATION (STREET NAME AND NUMBER)

TOWNSHIP LOT CONCESSION COUNTY/ DIST/ MUNIC CITY/ TOWN/ VILLAGE

NAD 83 | | || | | | | | | || | | | | | | |

ZONE EASTING NORTHING

Geo - Log:

COLOURS: WHITE, GREY, BLUE, GREEN, YELLOW, BROWN, RED, BLACK

MATERIALS: FILL, MUCK, PEAT, CLAY, SILT, GRAVEL, STONES, BOULDERS, TOP SOIL, LIMESTONE, FINE SAND, MEDIUM SAND, COARSE SAND, DOLOMITE, SHALE, SANDSTONE, SLATE, QUARTZITE, GRANITE, GREENSTONE

GENERAL DESPCRIPTION: LOOSE, POROUS, DENSE, PACKED, CEMENTED, LAYERED, SOFT, HARD, PREVIOUSLY DUG OR BORED, PREVIOUSLY DRILLED, WOOD FRAGMENTS

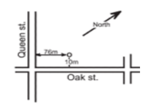
GENERAL COLOUR	MOST COMMON MATERIAL	OTHER MATERIALS	GEN. DESCRIPTION	COMMENTS	DEPTH (m/ft) FROM	TO

Figures 13-19 and 13-20 can be photocopied front to back and used in the field.

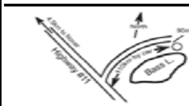
FIGURE 13-20: EXAMPLE OF THE BACK PAGE OF A LOG

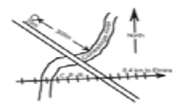
Map of Well Location:

RURAL AREAS



URBAN AREAS





LOT/CONCESSION NUMBERS NOT KNOWN

Results of Well Yield Testing:

	DRAWDOWN (cm/in)		RECOVERY (cm/in)	
After test of well yield, ☐Clear and sand free ☐Other	TIME (MIN.)	WATER LEVEL	TIME (MIN.)	WATER LEVEL
IF PUMPING DISCONTINUED, GIVE REASON	STATIC LEVEL			
	1		1	
	2		2	
PUMP INTAKE SET AT (m/ft)	3		3	
	4		4	
PUMPING RATE (l/min / GPM)	5		5	
	10		10	
DURATION OF PUMPING ______HRS + _____MIN	15		15	
	20		20	
FINAL WATER LEVEL END OF PUMPING (m/ft)	25		25	
	30		30	
	40		40	
DISINFECTED:	50		50	
☑YES ☐NO	60		60	

Construction Record - Screen

OUTSIDE DIAM. (cm/ in)	MATERIAL	SLOT #	DEPTH (m/ft) FROM	TO

Water Details:

WATER FOUND AT DEPTH ______(m/ft) ☐GAS	KIND OF WATER FRESH/UNTESTED/OTHER
WATER FOUND AT DEPTH ______(m/ft) ☐GAS	KIND OF WATER FRESH/UNFRESH/OTHER
WATER FOUND AT DEPTH ______(m/ft) ☐GAS	KIND OF WATER FRESH/UNFRESH/OTHER

Hole Diameter:

DEPTH (m/ft) FROM	TO	DIAM. (cm/in)

Construction Record - Casing:

INSIDE DIAM. (cm/ in)	OPEN HOLE OR MATERIAL	WALL THICK-NESS	DEPTH (m/ft) FROM	TO

LENGTHS OF CASING BROUGHT TO JOB SITE (m/ ft)

____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

LENGTHS OF CASING INSTALLED IN WELL (m/ft)

____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____ ____

Annular Space:

DEPTH (m/ft) FROM	TO	MATERAL	NO. BAGS PLACED

WELL OWNER'S INFO PACKAGE DELIVERED
YES _____ NO______
DATE PACKAGE DELIVERED (YY/MM/DD)
________/_________/_______.

Figures 13-19 and 13-20 can be photocopied front to back and used in the field.

14. Abandonment: When to Plug & Seal Wells

Chapter Table of Contents

Chapter Figures

Chapter Description

This chapter outlines when the **Wells Regulation** requires that a well be abandoned by the well owner or the person constructing the well. It also provides the steps that a well owner may take to seek written consent from the Director to allow for the continued use of the well. Chapter 15 *Abandonment: How to Plug & Seal Wells* outlines the sequential approach and materials used to plug and seal a well.

Regulatory Requirements – Abandonment: When to Plug and Seal Wells

Relevant Sections – The Wells Regulation

Abandonment - Section 21 (when to abandon a well)

The Requirements – Plainly Stated

The Wells Regulation requires a well to be abandoned based on the following:

When to Abandon a Well:

Person Constructing the Well

If construction is completely stopped (i.e. discontinued) before completion of the new well's structural stage and no other person completes the new well to its structural stage, the person constructing the well must immediately abandon the well (see pages **Error! Bookmark not defined.** and 13 of this chapter for further information).

Well Purchaser

The well purchaser of a new well that is dry must immediately abandon the well unless the owner of the land on which the well is situated agrees in writing to maintain the well for future use as a well.

Well Owner

The well owner must immediately abandon a well if it:

- is not being used or maintained for future use as a well,
- produces mineralized water,
- produces water that is not potable (unless the well owner seeks advice of, and follows, the directions of the local medical officer of health),
- contains natural gas or other gas (unless measures are taken by the well owner to manage the gas in a way that prevents any potential hazard),
- permits any movement of natural gas, contaminants or other materials between subsurface formations (aquifers), or between a subsurface formation and the ground surface, and the movement may impair the quality of any waters (unless measures are taken by the well owner that prevent the movement at all times), or
- is constructed in contravention of any provision of the **Wells Regulation** dealing with the location of wells, the methods and materials used in the construction of wells or the standards of well construction, and the steps taken to immediately rectify the situation have failed.

In most cases, the well purchaser or well owner will retain a licensed well contractor and well technician to abandon the well (see Chapter 15 *Abandonment: How to Plug & Seal Wells*).

Exemptions from Well Abandonment Requirements for Well Owners:

The well owner does not need to abandon the well if the well water is mineralized or not potable under the following scenario:

- the well is used or intended for use as a source of water for agriculture (such as watering livestock or irrigating crops); and
- the well is not used as a source of water for human consumption.

Seeking Advice from the Local Medical Officer of Health:

If the well owner needs to use a well producing water that is not potable the well owner may either immediately seek the advice of and take such measures as directed by the local medical officer of health or seek and obtain the written consent of the Director to allow for the continued use of the well. If these steps are not taken, the well owner must immediately abandon the well.

Director's Written Consent not to Abandon a Well:

The well owner is not required to abandon a well if the well owner has sought and obtained the written consent of the Director to allow for the continued use of the well for the following situations:

- A well produces mineralized water,
- A well produces water that is not potable and the well owner does not immediately seek advice from the local medical officer of health or does not follow the directions of the local medical officer of health,
- A well contains natural gas or other gas and the well owner has not taken measures to manage the gas to prevent any potential hazard,
- A well permits any movement of natural gas, contaminants or other materials between subsurface formations, or between a subsurface formation and the ground surface, and the movement may impair the quality of any waters and the well owner has not taken measures to prevent the movement, or
- A well is constructed in contravention of any provision of the **Wells Regulation** dealing with the:
  - location of wells,
  - methods and materials used in the construction of wells, or
  - standards of well construction, and
  - the well owner has not taken immediate steps to rectify the situation.

Relevant Sections – Additional Regulations or Legislation

Safe Water Drinking Act, S.O. 2002, Chapter 32 - Section 10

Safe Water Drinking Act, S.O. 2002, Chapter 32; Ontario Regulation 169/03, Ontario Drinking Water Quality Standards.

Key Concepts

What is an Improperly Abandoned Well?

An improperly abandoned well is one that has not been plugged and sealed and that is any of the following:

- No longer maintained for use as a well
- In such disrepair that its continued use for obtaining groundwater is impractical
- A well that has been left uncompleted

In some cases, wells that produce mineralized water (e.g. salty, sulphate-rich water) or water that is not potable need to be abandoned. Wells that produce an explosive or poisonous gas or do not meet construction or maintenance standards may need to be properly plugged and sealed (abandoned).

Figure 14-1: Improperly Abandoned Drilled Well

Figure 14-1 shows an example of an improperly abandoned drilled well within a large excavated open hole. The open excavation presents a physical hazard and a pathway for surface water runoff and other contaminants to enter the well water and groundwater resource.

Figure 14-2: Improperly Abandoned Dug Well

Figure 14-2 shows an example of an improperly abandoned dug well with large opening in the well cover. The opening in the well cover presents a physical hazard and a pathway for surface contamination to enter the well water and groundwater resource.

How Many Wells and Abandoned Wells are there in Ontario?

Most of Ontario's rural residents rely on groundwater to meet their water needs. From the late 1940s, well contractors have been required to report drilled and bored well construction operations to the well owner and the Ontario Government. In the late 1980s, all persons constructing dug wells were required to complete well records. Well records are required to be submitted to the Ministry to document the construction, alteration or abandonment of wells in Ontario. Over 600,000 well records have been submitted to the Ministry over the years with approximately 15,000 new well records received each year.

At this time no one knows exactly how many wells or abandoned wells exist in the Province of Ontario due to the evolving reporting requirements for wells.

If a well has been reported to the Ministry, a copy of the record can be requested from the Ministry to assist in the plugging and sealing of a well. The well record search request forms are available on the Government of Ontario Central Forms Repository website at www.forms.ssb.gov.on.ca (type "wells" in the search bar) or by contacting the Ministry's Water Well Help Desk at 1-888-396-9355 (Toll-Free for Ontario residents).

It is important that land owners understand their responsibilities under the **Wells Regulation**. It is important for environmental protection and health and safety reasons that land owners take the time to investigate and identify improperly abandoned wells that may exist on their property. The water well industry should assist land owners in identifying improperly abandoned wells when working on a property and inform them of their responsibilities under the **Wells Regulation**.

What Problems Do Improperly Abandoned Wells Present?

Improperly abandoned wells may pose any of the following problems:

- Act as pathways for the movement of near-surface contaminants such as bacteria into aquifers (groundwater supplies).
- Pose a threat to children, adults or animals who may fall into large diameter openings and become trapped or injured (Figure 14-3).
- Interconnect fresh groundwater with salty or mineralized groundwater zones and allow the mineralized water to enter into fresh water zones.
- Present a hazard to farm machinery and vehicles.
- Flow uncontrollably at the surface resulting in groundwater waste, nuisance or flooding problems (see Figure 14-4).

Figure 14-3: Improperly Abandoned Large Diameter

Figure 14-3 shows a large diameter improperly abandoned well with an open well cover (behind child). This can present a safety hazard for children.

Figure 14-4: Improperly Abandoned Flowing Well

Figure 14-4 shows an improperly abandoned flowing well causing flooding damage and wasting of the groundwater resource.

Merely capping or covering the top of a well is not enough to prevent the well from becoming a problem as shown in Figures 14-1 and 14-3.

To help protect the health and safety of humans and protect the environment, improperly abandoned wells need to be properly plugged and sealed.

How Can I Find Out if I Have an Improperly Abandoned Well on My Property?

A person may wish to inspect their property for signs of an existing unused well. Some indicators of unused wells include any of the following:

- pipe sticking out of the ground,
- concrete slab with or without a hand pump,
- ring of rocks or bricks,
- windmill,
- old shed (e.g. pump house),
- wooden slab on the ground,
- depression in the ground, or
- flowing water, or constant wet area on the ground surface.

Figure 14-5: Hidden Dug Well

In many cases, brush or debris can hide a well. As shown in Figure 14-5, tall grass and brush hide an open and deteriorated large diameter dug well.

Figure 14-6: Contamination and Safety Risk

In Figure 14-6, the hidden open dug well presents a hazard to humans and easy access for surface water and other foreign materials to enter the groundwater resource.

If there is a possibility that a well is buried below the ground surface, the following sources of information may assist in locating the well:

- Former property owners or neighbours
- Well record reports
- Property surveys
- Old photographs
- Fire insurance plans
- Former septic system plans

In some cases, a metal detector can be used to locate a buried well that has a steel casing. If the horizontal waterline(s) still extend from the buried well into a building, a plumber's video camera equipment moving through the waterlines to the well, and an above ground camera equipment receiver, may be used to locate a well.

FIGURE 14-7: BURIED WELL AND WATER LINES

Figure 14-7 shows a buried drilled well and waterlines exposed after excavating from the ground surface. Buried wells are difficult to locate and detection devices may be needed. In this case there is no well cap to stop surface water or other foreign materials from entering the well.

Who is Responsible for Plugging and Sealing Wells?

Well owners, well purchasers or persons constructing wells must abandon (plug and seal) any well using the nine (9) sequential step approach (see Chapter 15: *Abandonment: How to Plug and Seal Wells*) for unfinished wells, certain well construction and maintenance deficiencies, water quantity problems and water quality problems. These requirements are described in the following sections.

Well owners, well purchasers and persons constructing wells are subject to enforcement actions, such as orders and/or prosecution, if abandoned wells are not properly plugged and sealed or if groundwater contamination results.

The abandonment requirements of the **Wells Regulation** apply to all wells (e.g. domestic, municipal, agricultural or testing). Well owners may also be liable if a person is injured due to an improperly abandoned well on their property.

By eliminating both the physical hazards and contamination pathways, well owners are protecting the water quality of existing and future wells and the groundwater. By taking these precautions, well owners are also reducing potential financial liabilities while making a wise investment in the future.

When this chapter refers to the “well owner” or “well purchaser” being required to abandon a well or addressing a specific issue with the well, it is understood that the person doing the work should have the appropriate expertise. Although the **Wells Regulation** allows a residential well owner to abandon his/her own well without a licence, the equipment, materials and expertise needed to comply with the requirements under the **Wells Regulation** far exceed the average well owner’s abilities and resources. See Chapter 15: *Abandonment: How to Plug and Seal Wells*.

Who is Legally Responsible for Plugging and Sealing Unfinished New Wells?

If the construction of a new well has been discontinued prior to the completion of the well’s structural stage, the person constructing the well must plug and seal it using the nine (9) sequential step approach required by the **Wells Regulation** (see Chapter 15: *Abandonment: How to Plug & Seal Wells*).

A well's structural stage is complete on the day on which the well is capable of being used for the purpose for which it was constructed, except for any of the following:

- Compliance with disinfection requirements of the **Wells Regulation,**
- The installation of a pump (which includes any associated pumping equipment) or
- Any alteration necessary to accommodate pumping, monitoring, sampling, testing or water treatment equipment.

The structural stage of a new well is complete after:

- The well casing and well screens have been installed
- The annular space has been filled,
- The control device has been installed on a flowing well,

- Well development has been completed,
- The well yield has been tested, and
- The well tag has been affixed to the well.

Persons constructing new wells, well owners, and well purchasers should be aware that the construction of a well is not deemed discontinued when the following situations apply:

- A person has completed all of the above except for affixing a well tag, developing a well or conducting a yield test.
- A person cannot finish the new well due to an equipment breakdown or other reason and the well purchaser will be hiring another person to finish the well within a reasonable time.

When are Well Purchasers Legally Required to Abandon a Well?

The **Wells Regulation** requires well purchasers to immediately abandon (plug and seal) a new well that is dry using the nine (9) sequential step approach which includes determining required expertise (see Chapter 15: *Abandonment: How to Plug & Seal Wells*).

A well purchaser is a person who has entered into a contract for the construction of a well with a person who is engaged in the business of well construction (well contractor).

Well purchasers are exempt from this abandonment requirement if the owner of the land on which the well is situated agrees in writing to maintain the well for future use as a well. For example, a well that may be dry at the time of construction may, after a few days or weeks, slowly yield groundwater.

The needs of the well purchaser will determine what constitutes an adequate water supply. There are many purposes for wells including agriculture, irrigation, industrial and drinking water. Wells yielding low quantities of groundwater may have sufficient storage or can be supplemented with alternate storage supplies. Therefore, many low yielding wells are used throughout rural Ontario as domestic drinking water supplies or for other purposes.

The **Wells Regulation** is intended, in part, to prevent wells from creating a pathway for contamination and includes requirements for reporting problems to the well owner, the well purchaser and in some cases the Ministry.

It is not necessary to abandon a well that may not have a sufficient yield if the well owner:

- maintains the well for future use as a well in a manner sufficient to prevent the entry of surface water and other foreign materials, or
- continues to use and maintain the well in a manner sufficient to prevent the entry of surface water and other foreign materials.

When are Well Owners Legally Required to Abandon a Well?

A) Maintenance

The **Wells Regulation** requires a well owner to immediately abandon (plug and seal) a well that is not being used or maintained for future use as a well using the nine (9) sequential step approach, which includes determining required expertise (see Chapter 15: *Abandonment: How to Plug & Seal Wells*).

For example:

A municipal water distribution system has been installed in a number of residences that originally relied on private wells. Unless there is a reasonable chance that the wells will be used and the wells are maintained in a manner sufficient to prevent the entry of surface water and other foreign materials, the well owners would be required to immediately abandon the wells.

B) Mineralized Water

The **Wells Regulation** considers the well water to be mineralized when well water contains concentrations of chlorides or sulphates at more than 500 mg/L or total dissolved solids at concentrations of more than 6,000 mg/L.

The **Wells Regulation** requires a well owner to immediately plug and seal a drinking water well that produces water that is not potable using the nine (9) sequential step approach , which includes determining required expertise (see Chapter 15: *Abandonment: How to Plug & Seal Wells*).

For example:

A well owner operates a private domestic well used for human consumption. The well has a salty taste. The well owner submits samples of raw well water to a licensed laboratory. The sample determinations show chloride concentrations significantly above 500 mg/L. In this instance the well is producing mineralized water as defined in the **Wells Regulation** and therefore the well owner would be required to immediately abandon the well.

Exemptions

The requirement to abandon wells producing mineralized water does not apply to any of the following circumstances:

- wells used or intended for agricultural purposes such as watering livestock or crops and that are not used as sources of water for human consumption,
- wells defined as a test hole or dewatering well, or
- wells where the Director has provided a written consent not to abandon the well producing mineralized water (see the "Director's Exemptions for Well Owners" section on page 20 of this chapter).

C) NOT POTABLE WATER

The *Safe Drinking Water Act, 2002,* requires "potable water" to meet at least the standards prescribed in the Ontario Drinking Water Quality Standards (Ontario Regulation 169/03 as amended, under the *Safe Drinking Water Act*, 2002)

Ontario

The **Wells Regulation** requires a well owner to immediately plug and seal many types of wells including domestic wells using the nine (9) sequential step approach, which includes determining required expertise (see Chapter 15: *Abandonment: How to Plug & Seal Wells*).if drinking water wells produce water that is not potable (i.e. does not meet one or more of the standards found in the Ontario Drinking Water Quality Standards).

For example:

A well owner operates a private domestic well used for human consumption. The well owner submits samples of raw well water to a licensed laboratory for bacterial analyses. The sample determinations show the presence of *Escherichia coli* (*E.coli*) in the well water. In this instance the well is producing water that is not potable. The well owner would be required to do one of the following:

- immediately abandon the well, or
- seek the advice of, and take such measures as directed by, the local medical officer of health (see the "Seeking Advice from the Local Medical Officer of Health" section on page 22 of this chapter).

The measures specified by the local medical officer of health, such as the installation and use of water treatment devices, must be functional at all times.

Exemptions

The requirement to abandon wells producing water that is not potable does not apply to any of the following circumstances:

- Wells used or intended for agricultural purposes such as watering livestock or crops and that are not used as sources of water for human consumption,
- Wells defined as a test hole or dewatering well, or
- Wells where the Director has provided a written consent not to abandon wells producing water that is not potable (see the: "Director's Exemptions for Well Owners" section on page 20 of this chapter).

D) Natural Gas

Ontario

The **Wells Regulation** requires a well owner to immediately plug and seal a well that contains natural gas or other gas using the nine (9) sequential step approach, which includes determining the need for expertise (see Chapter 15: *Abandonment: How to Plug & Seal Wells*).

Abandonment is not required if the well owner takes measures to manage the gas in a way that prevents any potential hazard.

For example:

A well owner operates a private domestic well used for human consumption. It has been established through testing and observations that naturally occurring methane gas from the well water is entering the home and is posing an explosion risk. In this instance, there would be enough information to conclude the well is producing naturally occurring gas. The well owner would be required to do one of the following:

- Immediately abandon the well, or
- Take measures to manage the gas in a way that prevents any potential hazard.

The measures taken to manage the gas must be functional at all times (see Chapter 9: *Equipment Installation*).

Exemptions

The requirement to abandon wells producing naturally occurring or other gas(es) does not apply where the Director has provided a written consent not to abandon wells producing gas (see the "Director's Exemptions for Well Owners" section on page 20 of this chapter).

E) WELLS ACTING AS PATHWAYS

Ontario

The **Wells Regulation** requires a well owner to immediately plug and seal a well that acts as a pathway for the movement of:

- natural gas,
- contaminants, or
- other materials

between subsurface formations (including aquifers) or between the ground surface and a subsurface formation. Where the movement may impair the quality of the waters using the nine (9) sequential step approach (see Chapter 15: *Abandonment: How to Plug & Seal Wells*).

For example:

a) A flowing well is allowing groundwater with elevated naturally occurring uranium in an aquifer to discharge into a nearby cold water creek. The elevated uranium may impair the surface water of the creek.

b) Surface water runoff containing bacteria is allowed to move from the ground surface through an open hole in the well casing of a well. The surface water runoff containing bacteria may impair the water in the well and aquifer.

In both instances there would be enough information to conclude the well is acting as a pathway that may impair the waters. The well owner would be required to do one of the following:

- immediately abandon the well, or
- take measures to prevent any movement at all times.

The measures taken must be functional at all times.

Exemptions

The requirement to abandon a well that acts as a pathway does not apply where the Director has provided a written consent not to abandon wells (see the "Director's Exemptions for Well Owners" section on page 20 of this chapter).

F) WELLS IN CONTRAVENTION OF THE WELLS REGULATION

Ontario

The **Wells Regulation** requires a well owner to immediately plug and seal all wells using the nine (9) sequential step approach, which includes determining required expertise (see Chapter 15: *Abandonment: How to Plug & Seal Wells*) if a well is constructed in contravention of any provision of the **Wells Regulation** and the immediate steps taken by the well owner to rectify the contravention have failed dealing with any of the following:

- Location of wells,
- Methods and materials used in the construction of wells, or
- Standards of well construction.

For example:

a) Improper well locations include a drilled well located within 15 metres (50 feet) of a septic tank and leaching bed system or a well located in a low lying ditch.

b) An improper method used in the construction of a well may be installing bentonite or concrete in the annular space of a drilled well from the ground surface without the aid of a tremie pipe.

c) Improper materials used in the construction of a well may be the installation of permeable sand in the annular space of a well that allows movement of contaminants from the ground surface to an aquifer.

d) Improper standards of well construction may be the use of steel well casing in a drilled well that does not meet the nominal and minimum thickness required by the **Wells Regulation** and/or does not meet ASTM International standards specified by the **Wells Regulation**.

In these examples, there is a potential for the well to act as a pathway for contaminants to enter the groundwater resource or the well has not been constructed to the required minimum standard. In these instances the well owner would be required to immediately do the following:

- take steps to rectify the problem; but
- if the steps fail, abandon the well.

In other scenarios, a case by case evaluation may be required to determine whether a contravention of the **Wells Regulation** triggers a well to be abandoned by the well owner.

Examples of contraventions of the **Wells Regulation** requirements that would not require the well owner to immediately take measures, and if necessary, abandon the well are:

- improper well record completion or reporting,
- failure to provide written records of the testing during disinfection,
- lack of a well tag on the well or improperly affixing the well tag,
- improper yield tests,
- failure to properly notify the well purchaser and the owner of the land of water quality issues or gas, or
- failure to provide the well purchaser with a well information package or to measure the depth of the well in the presence of the well purchaser.

Even though the above noted types of contraventions are exempted from the requirement to immediately take measures to rectify the problem, and if necessary abandon the well, these contraventions are, however, subject to enforcement actions (e.g. orders, fines).

Exemptions

The requirement to immediately take measures to rectify a well that is in contravention of a requirement in the **Wells Regulation** does not apply to the well owner where the Director has provided written consent (see the “Director’s Exemptions for Well Owners” section on page 20 of this chapter).

The requirement to immediately abandon a well, if the measures taken to rectify the contravention fail, does not apply where the Director has provided written consent (see the “Director’s Exemptions for Well Owners” section on page 20 of this chapter).

When a well owner is legally required to abandon a well, there are a number of site specific considerations that should be assessed to determine whether the well can be repaired or must be abandoned (properly plugged and sealed). Examples of considerations include: geology, hydrogeology, treatment, other sources of water and costs. Well owners should consider retaining experts such as hydrogeologists, water well contractors and water treatment specialists, when assessing the options.

The abandonment requirements for well owners in this section apply to all wells except for the abandonment requirement where wells are constructed in contravention of the location of wells, methods and materials used in the construction of wells or the standards of well construction in the current **Wells Regulation**. For example, the requirement to repair a well where it is constructed in contravention with the current **Wells Regulation** construction or location requirements will apply to any well constructed on or after December 31, 2007. In other words, the requirements in force at the time of construction apply to that well.

DIRECTOR'S EXEMPTIONS FOR WELL OWNERS

WHEN CAN A WELL OWNER SEEK AN EXEMPTION?

The well owner is not required to abandon a well if the well owner has sought and obtained the written consent of the Director to allow for the continued use of the well for any of the following situations:

- A well produces mineralized water,
- A well produces water that is not potable and the well owner does not immediately seek advice from the local medical officer of health or does not follow the directions of the local medical officer of health,
- A well contains natural gas or other gas(es) and the well owner has not taken measures to manage the gas to prevent any potential hazard,
- A well permits any movement of natural gas, contaminants, or other materials between subsurface formations, or between a subsurface formation and the ground surface, and the movement may impair the quality of any waters and the well owner has not taken measures to prevent the movement, or
- A well is constructed in contravention of any provision of the **Wells Regulation** dealing with the:
  - Location of wells,
  - Methods and materials used in the construction of wells, or
  - Standards of well construction, and
  - Measures taken to immediately rectify the situation have failed.

If the well owner has sought and obtained written consent from the Director, the well owner is not required to take immediate measures to rectify or abandon a well that is in contravention of any provision of the **Wells Regulation** dealing with the:

- location of wells,
- methods and materials used in the construction of wells, or
- standards of well construction.

WHERE DOES THE WELL OWNER HAVE TO GO TO SEEK A WRITTEN CONSENT FROM THE DIRECTOR?

If a well owner wishes to seek the written consent of the Director, the well owner may contact the Water Well Help Desk:

- In writing to Water Well Help Desk, Environmental Monitoring and Reporting Branch of the Ministry of the Environment, 125 Resources Road, Etobicoke ON M9P 3V6,
- By telephone at 1-888-396-9355 (for Ontario residents only),
- By fax at: 416-235-5960, or
- By e-mail at helpdesk@waterwellontario.ca

WHAT INFORMATION IS NEEDED FOR A WRITTEN CONSENT?

The Director reviews each case individually and on its merits. As a minimum, applicants contacting the Ministry for a written consent should provide a written request with the following information:

- The name of the individual(s)/entity that owns the well
- The location of the well
- An indication as to whether or not the well in question is new or an existing well (date of construction)
- The purpose of the well
- The reason for the exemption (e.g. contaminant(s) of concern encountered, contravention of the **Wells Regulation**)
- If applicable, an overview of the proposed process to treat the contaminant(s) of concern (e.g. to meet the applicable Ontario Drinking Water Quality Standard)
- If applicable, written certification by the manufacturer/installer of the treatment technology demonstrating that the proposed treatment process will be effective in treating the contaminant of concern
- Historical and current water quality information on both raw and treated samples of the water extracted from the well in question and
- If applicable, the justification as to why the well does not need to be immediately abandoned (e.g. well can be allowed to stay in contravention of the **Wells Regulation** if temporary measures are in place to eliminate physical hazards and protect the groundwater until a final rectification occurs etc.)

Depending on if there are well design issues, water quality issues or gas issues, a well owner may be required by the Director to retain a *Professional Engineer*, *Professional Geoscientist* and/or a water treatment specialist who would have to prepare a scientific report showing the appropriate scientific rationale to support the well owner's application. The well owner would then submit the report, along with the request for written consent, to the Ministry for its consideration.

Depending on the case and as part of the Director's consideration, the Director may ask other regulators and interested parties to comment on the application. For example, a proposed subdivision may not have the support of the approving authority (municipality) if well water has elevated chlorides or other mineralized water in private domestic wells.

HOW DOES THE DIRECTOR'S DECISION PROCESS WORK?

The request for written consent should be submitted to the Director along with any and all supporting documents such as a hydrogeological and/or a well design report. Well owners and others should be cautioned that obtaining a written consent will not be a simple and automatic process, since the Ministry has to provide for the conservation, protection and management of Ontario's waters and for their efficient and sustainable use, to promote Ontario's long-term environmental, social and economic well being.

The Director will review the request, supporting information and other information generated from internal and external parties with an interest in the application.

Based on the information, the Ministry will contact the well owner in writing indicating the Director has:

- Issued the written consent to the well owner,
- Refused to issue the written consent and thus, requires the well owner to immediately abandon the well, or
- Requested additional information from the well owner to allow the Ministry to make a decision.

Seeking Advice from the Local Medical Officer of Health

Medical Officer of Health Exemption from Abandonment for a Well Producing Water that is Not Potable

How To Find the Local Medical Officer of Health

There are 36 public health units in Ontario. A public health unit is governed by a board of health and is administered by the medical officer of health who reports to the local board of health.

To determine which local public health unit in Ontario covers an area, do any of the following:

- Call 1-866-532-3161,
- Review the blue pages of the telephone book, or
- Check the information at the following website:

  http://www.health.gov.on.ca/english/public/contact/phu/phuloc_mn.html

When Should the Public Health Unit (Local Medical Officer of Health) Be Contacted?

Potable means water that meets the Ontario Drinking Water Quality Standards found in Regulation 169/03 as amended made under the *Safe Drinking Water Act, 2002.* The regulation can be found at the following website address:

http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_030169_e.htm

When a well produces well water that is not potable (i.e. does not meet one or more of the Ontario Drinking Water Quality Standards), the well owner may seek the advice of and take such measures directed by the local medical officer of health as an alternative to immediately abandoning the well.

This requirement applies to all wells except those wells that are used or intended for use as a source of water for agriculture and are not used as a source of water for human consumption.

What kind of Advice and Direction Will be Given by the Public Health Unit?

The *Protocol Respecting Safe Water Program*, 12 December 2003 and the *Memorandum of Understanding between the Ministry of the Environment and the Ministry of Health and Long-Term Care Concerning The Safe Drinking Water Program*, October 1, 2003, provide the roles and responsibilities of the local public health unit and the local office of the Ministry of the Environment for wells that produce water that is not potable. The most current versions of the protocol and memorandum of understanding (MOU) are available at the following website addresses:

http://www.health.gov.on.ca/water/5_sw_proto.pdf

http://www.health.gov.on.ca/water/3_mou.pdf

In response to a water quality concern in a private domestic well with water that is not potable, public health unit staff will base their direction, at a minimum, on the most current edition of the water wells resource kit *Keeping Your Well Water Safe To Drink* and any other resource material that may be available from the health unit. The public health unit staff will advise the private residential well owner to follow the steps outlined in the direction provided to them.

The kit is available at the following website address:

http://www.health.gov.on.ca/english/public/pub/watersafe/watersafe_wellknow.html

If the well is part of a regulated system under the *Safe Drinking Water Act*, or a small drinking water system under the *Health Protection and Promotion Act*, the local office of the Ministry of the Environment and the public health unit will use the protocol and MOU in responding to notifications of well water that is not potable, in providing direction to the well owner and in communicating the action taken between the public health unit and the local office of the Ministry of the Environment to resolve the issue.

The protocol and MOU also allow the public health unit to seek assistance from the local office of the Ministry of the Environment in certain cases (e.g. to identify sources of contamination).

WHAT HAPPENS AFTER DIRECTION HAS BEEN GIVEN BY THE PUBLIC HEALTH UNIT?

The **Wells Regulation** requires that, once measures have been taken to rectify the well water potability problem (such as the installation of water treatment devices) under the direction of the local medical officer of health, the well owner must ensure that the measures remain functional at all times.

Reports of failure to follow the advice and direction of the local public health unit (local medical officer of health) are to be referred to the local office of the Ministry of the Environment.

Glossary

Some of the terms in this Glossary are reprinted with permission from the following sources:

- **GWW =** *Groundwater and Wells: Third Edition*. 2007. Robert J. Sterrett (editor). Johnson Screens/a Weatherford Company. New Brighton, Minnesota. Glossary (Pp. 753-774)
- **NGWA =** *Illustrated Glossary of Driller's Terms*. 2004. National Ground Water Association Inc., Westerville, Ohio
- **ASTM D5092** = Standard Practice for Design and Installation of Ground Water Monitoring Wells. ASTM International, West Conshohocken, PA.
- **ASTM D5784** = Standard Guide for the Use of Hollow-Stem Augers for Geoenvironmental Explorations and the Installation of Subsurface Water-Quality Monitoring Devices. ASTM International, West Conshohocken, PA.
- **Gowen =** Gowen Environmental Ltd. – Online Glossary available at: http://www.contaminatedsite.com

ACID – Any chemical compound containing hydrogen capable of being replaced by positive elements or radicals to form salts. In terms of the dissociation theory, it is a compound which, on dissociation in solution, yields excess hydrogen ions. Acids lower the pH. Examples of acids or acidic substances are hydrochloric acid, tannic acid, and sodium acid pyrophosphate. (GWW)

AGGREGATE – Granular mineral or rock material (e.g. sand, gravel) that is mixed with cement to form concrete. (Gowen)

AIR VACUUM VALVE - A relief valve designed to allow air to enter into and vent from a water system at a high volume. When water encounters the valve, a weighted ball seals to a plate in the valve and creates a watertight seal.

AIR RELEASE VALVE - A relief valve designed to allow gases (that build up in the water column) to slowly vent from the water column. When water encounters the valve, a weighted ball seals to a plate in the valve and creates a watertight seal.

AIRLIFT – To lift water or drilling fluid to the ground surface (GWW/NGWA) by pushing high velocity compressed air through the drilling stem.

ALKALINE – Any of various soluble mineral salts found in natural water and arid soils having a pH greater than 7. In water analysis, it represents the carbonates, bicarbonates, hydroxides, and occasionally the borates, silicates, and phosphates in the water. (GWW)

AQUIFER TEST – A test which involves adding to or discharging measured quantities of water from a well, and recording the resulting changes in head in the aquifer (during and after addition/withdrawal). Examples are slug tests, bail tests and pumping tests. (Gowen)

AQUITARD – A geological formation that may contain groundwater but it is not capable of transmitting significant quantities of groundwater under normal hydraulic gradients (e.g. clay layers). In some situations aquitards may function as confining beds. Aquiclude is a term sometime used to refer to a geologic layer of very low permeability, but it is outdated; aquitard or confining layer are preferred terms (Gowen)

ARTESIAN – The condition of water in a confined aquifer being under sufficient pressure that the potentiometric surface is above the bottom of the overlying confining bed. The water level within a well in an artesian (or confined) aquifer rises to a point above the bottom of the confining bed that overlies the aquifer. It is not necessary for the water to flow at ground surface. If the water is under enough pressure, the potentiometric surface may be above the ground surface. In this case, water may actually flow from the well without pumping. Such a well is a flowing artesian well (or flowing well). (Gowen)

ARTESIAN AQUIFER – see Confined Aquifer.

BACKFILL – Material used temporarily during construction or permanently to replace material being removed. (Gowen)

BACKWASHING (WELL DEVELOPMENT) – A well development technique that uses surging or reversal of water flow in a well. The procedure removes fine material from the formation surrounding the well screen which can enhance well yield.

BACTERIA – Unicellular microorganisms that exist as free living organisms or as parasites and have a broad range of biochemical, and often pathogenic, properties. (Gowen)

BACTERICIDE – A substance that destroys bacteria. (Gowen)

BAILING – To remove sediment, water, drill cuttings or other debris from a well or hole with a bailer. (GWW/NGWA)

BAILER – A cylinder (or tube) suspended from a cable or rope to remove sediment, drill cuttings, water or other material from a well. A bailer has an open top and a check valve at the bottom. Bailers such as dart valve or flapper valve bailers can be large and operated from a drilling rig. Other bailers used to sample water are small enough to be hand held.

BAIL TEST (RISING HEAD TEST) – An aquifer test carried out to determine in-situ hydraulic conductivity by instantaneously removing a known volume of water from a well and measuring the resulting water level recovery in the well. (Gowen)

BALL VALVE – A valve regulated by the position of a free-floating ball that moves in response to fluid or mechanical pressure. (Gowen)

BARITE - Natural finely ground barium sulfate used for increasing the density of drilling fluids. (GWW)

BENTONITE GRANULES AND CHIPS – Irregularly shaped particles of bentonite (free from additives) that have been dried and separated into a specific size range. [1]

BENTONITE PELLETS – Roughly spherical- or disc- shaped units of compressed bentonite powder (some pellet manufacturers coat the bentonite with chemicals) that may be coated with some chemicals.[1]

BIT (DRILL BIT) – The cutting tool attached to the base or bottom end of the drill string that breaks the formation into smaller pieces (cuttings) during drilling. Its design varies according to the type of formation and drilling equipment used. (GWW/NGWA)

BLOWOUT – An uncontrolled escape of drilling fluid, gas, oil or water from the well, caused by the formation pressure being greater than the hydrostatic head of the fluid in the hole. (GWW)

BOREHOLE – A subsurface hole that may or may not be cased and is typically round in plan view. The borehole is typically drilled, augered or bored into the ground.

BREATHING WELL (SUCKING & BLOWING): Conditions where the well and aquifer formation are significantly affected by changes in atmospheric pressure which can cause the periodic suction and expulsion of gases. Sucking and blowing (breathing) wells have been linked to the accumulation of gases low in oxygen in well pits leading to asphyxia.

BRIDGE – A bridge is usually formed by the caving of the wall of the well; by the intrusion of a large boulder; by improper placement of sealant; or; by improper placement of filter pack materials during well construction. Bridging can also occur in the formation during well development. GWW/NGWA (modified)

BULK DENSITY – The amount of mass of a soil per unit volume of soil; where mass is measured after all water has been extracted and the total volume includes the volume of the soil itself and the volume of the air space (voids) between the soil grains. (Gowen)

CASING DRIVER - a device fitted to the tophead drive of a direct rotary rig's mast. It allows the casing to be advanced during drilling but allows the drilling and driving to be adjusted independently.

CASING JACKS – Hydraulic jacks used to pull casing or the drill stem from the well. (GWW/NGWA)

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[1] Reprinted, with permission, from Standard Guide for the Use of Hollow-Stem Augers for Geoenvironmental Explorations and the Installation of Subsurface Water-Quality Monitoring Devices D5784-95 (Reapproved 2006), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

Casing Rotator - a device installed on a drilling rig that clamps around the casing. Once the rotator clamps onto the casing, the rotator can be rotated clockwise or counter clockwise into the ground. It also can adjust the distance between the casing and the drilling bit. (GWW)

Caving (Sloughing) – The inflow of unconsolidated material into a borehole that occurs when the borehole walls lose their cohesiveness. [2]

Cavitation – A phenomena of cavity formation, or formation and collapse, especially in regard to pumps, when the absolute pressure within the water reaches the vapour pressure, causing the formation of vapour pockets. (GWW)

Cement (commomly known as Portland Cement) – A mixture that consists of calcareous, argillaceous, or other silica, alumina-, and iron-oxide-bearing materials that is manufactured and formulated to produce various types which are defined in Specification C 150 (ASTM standard- *Specification for Portland Cement).* Portland Cement is considered hydraulic cement because it must be mixed with water to form a cement-water paste that has the ability to harden and develop strength even if cured under water. [2]

Centralizer – A device that assists in the centering of a casing or riser within a borehole or another casing. [2]

Centrifugal Pump – A pumping mechanism that spins water by means of an "impeller". Water is pushed out by centrifugal force. Centrifugal deep-well jet pumps work with two lines into the well. As water is moved at the surface by an impeller, some of the water is returned to the well to the ejector assembly above the intake. This return water creates a "venturi" effect in the ejector, sucking well water through the check valve.

Check Valve – A mechanical device which normally allows a fluid or gas to flow through it in only one direction. There are various types of check valves for various needs. Check valves typically work automatically. An important concept in a check valve is the cracking pressure which is the minimum upstream pressure at which the valve will operate. Thus, the check valve is designed for a specific cracking pressure.

Collar (Stabilizer) – A length of extremely heavy steel tube used in well drilling. It is placed in the drill string immediately above the drill bit to minimize bending, maintain plumbness, and provide weight on the drill bit while drilling. (GWW/NGWA)

Cone of Depression – The area around a discharging well where the hydraulic head (potentiometric surface) in the aquifer has been lowered by the pumping. In an unconfined aquifer, the cone of depression is a cone-shaped depression in the water table where the formation has actually been dewatered. (Gowen)

Confined Aquifer (Artesian Aquifer) – A fully saturated aquifer overlain by a confining layer. The potentiometric surface (hydraulic head) of the water in a confined aquifer is at an elevation that is equal to or higher than the base of the overlying confining layer. Discharging wells in a confined aquifer lower the potentiometric surface which forms a cone of depression, but the saturated formation is not dewatered. (Gowen)

Confining Bed (Unit) – A geologic bed of impermeable (or very low permeable) material stratigraphically adjacent to one or more aquifers. Confining bed is commonly used to replace terms such as aquiclude, aquitard and aquifuge. (Gowen)

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[2] Reprinted, with permission, from D5092-04e1 Standard Practice for Design and Installation of Ground Water Monitoring Wells, copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

CONFINING LAYER - A geologic body of low hydraulic conductivity above or below one or more aquifers. Confining layer is commonly used to replace the term aquiclude. (Gowen)

CONSOLIDATED FORMATIONS – Geologic formations of natural material that has been lithified. The lithification creates a material with high strength and resistance to disintegration. (Gowen)

CORROSION – The act or process of dissolving or wearing away metals. (GWW)

CUTTINGS (DRILL CUTTINGS) –Fragments of soil or rock created by the drilling process with or without a drilling fluid (e.g. water). (Gowen)

DENSITY – The amount of mass per unit volume. (Gowen)

DEWATERING – Removing or draining water to lower the water table or potentiometric surface (e.g. by pumping a well or letting groundwater flow from a flowing well). Dewatering is commonly done during construction activities and to keep underground structures dry.

DISCHARGE AREA – An area in which there is upward groundwater flow in the subsurface. Groundwater flows toward the surface in a discharge area and may escape as a spring, seep or baseflow. A discharge area can also be an area where water, heavily chlorinated water or other material is discharged from a well. (Gowen)

DOWNGRADIENT – A downward hydrologic slope that causes groundwater to move toward lower elevations. Wells downgradient of a source of contamination are prone to receiving the contaminant's parameters at elevated concentrations. (Gowen)

DRAWDOWN – A lowering of the water table in an unconfined aquifer or the potentiometic surface of a confined aquifer caused by the pumping of groundwater from a well. (Gowen) The difference between the static water level (SWL) and the pumping water level (PWL) in a well. Drawdown = PWL - SWL.

DRILL BIT – See Bit.

DRILL COLLAR – See Collar. Drill Cuttings – See Cuttings.

DRILL HOLE – See borehole.

DRILL ROD (PIPE) – Special hollow jointed or coupled rods (pipes) that are used in creating a drill string from the rotating mechanism (typically with the drilling rig) to the bit. (Gowen)

DRILL RIG – Any rotary drilling equipment (e.g. standard, reverse, barber and dual), percussion, cable tool (e.g. churn and percussion) and diamond drilling equipment.

DRILL STRING – The string includes the drill rods (pipes) attached from the rotating mechanism to the collar, the collar and the bit. The drill string is used to transmit rotation from the rotating mechanism (typically with the drilling rig) to the bit. The drill string conveys air or drilling fluid which removes cuttings from the hole and cools the bit.

DRILLING FLUID – A water, bentonite-water or air-based fluid used in well drilling to remove cuttings from the hole, to clean and cool the bit, to reduce friction between the drill string and the sides of the hole, and to seal the hole. When a bentonite-water mixture is used it is sometimes called mud or drilling mud.

DRIVE SHOE – A forged steel collar on the bottom of a casing. The collar has a cutting edge to shear off irregularities in the hole as it advances. A drive shoe is considered casing and is used to form a seal between the casing and the bedrock. (Gowen)

DROP PIPE – The pipe (riser pipe or waterline) that carries water from a pump in a well (or from a foot valve) up to the surface through the top of the well or to a pitless adapter. The drop pipe is considered to be part of a pump as defined by the Wells Regulation.

DRY WEIGHT – The weight of a sample based on percent solids. The weight after drying in an oven. (Gowen)

EQUILIBRIUM - Condition that exists in a system when the system does not undergo any change of properties with the passage of time. Typically multiple forces produce a steady state (balance) resulting in no change over time. (Gowen)

EROSION – The general process whereby the materials of the earth's crust are moved from one place to another by running water (including rainfall), waves and currents, glacier ice, or wind. (Gowen)

FILTER PACK – Filter packs are well sorted gravels or coarse sands that can be:

- Developed around the well screen (naturally developed from native granular material);
- Selected and placed into the hole surrounding the well screen and developed (artificial filter pack), or
- Pre-packed between two manufactured well screens (called "pre-packed well screens") and developed.

This "packed" zone separates the well screen from the natural aquifer material to prevent finer materials from entering the well and increases the effective well diameter. The filter pack should extend several metres above the top of the screen to allow for settling during development.

FISHING – Retrieving a lost object in a well.

FLOWING (ACTIVE) SAND – A saturated sand deposit that flows upward into a well. Flowing sand problems typically occur during well construction when the hole reaches the saturated sand deposit. Flowing sand is also known in the industry as "running sand" or "active sand".

FLOWING ARTESIAN WELL – A flowing well (see flowing well and static water level in Chapter 2: *Definitions & Clarifications*, Table 2-1)

FORMATION – A mappable body of bedrock or overburden material that is recognizable by its physical and mineralogical characteristics and by its location within the geological time record (see subsurface formation in Chapter 2: *Definitions & Clarifications*, Table 2-1).

FORMATION STABILIZER – Sand or gravel placed in the annular space of the well to provide temporary to long-term support for suitable sealant in the annular space of a well.

FRACTURE – Voids in bedrock or overburden (e.g. till or clay) as a result of structural stresses (e.g. folding or faulting).

GEL – A state of a colloidal suspension in which shearing stresses below a certain finite value fail to produce permanent deformation. Gels commonly occur when the dispersed colloidal particles have a great affinity for the base fluid. (GWW)

GEL STRENGTH –The thixotropic (i.e. fluid when mixed and gel when left to stand) property of a drilling fluid that allows it to form a gel when it stops moving. (GWW/NGWA)

GEOLOGICAL LOG – See Log of Overburden and Bedrock materials in Chapter 2: *Definitions & Clarifications*, Table 2-2.

GRADED – An engineering term pertaining to a soil or an unconsolidated sediment consisting of particles of several or many sizes. The material can be described as well graded or poorly graded. (GWW)

GRADIENT – The rate of change in value of a physical or chemical parameter per unit change in position. (GWW/NGWA)

GRAIN SIZE – General dimensions of sediment or rock particles. (GWW/NGWA)

GRAVEL PACK – See filter pack.

GROUNDWATER – Underground water that fills pores in soils or openings in bedrock to the point of saturation. (Gowen)

GROUNDWATER DIVIDE – The rather vague division between groundwater basins. (Gowen)

GROUNDWATER FLOW – The movement of groundwater through openings in overburden and bedrock. (Gowen)

GROUNDWATER MINING – The permanent depletion of groundwater resources. (Gowen)

GROUNDWATER RECHARGE (CATCHMENT) AREA – An area that contributes to the natural replenishment (recharge) of the groundwater. It may include localized discharge areas. It typically includes the infiltration of precipitation and its movement through pores and fractures to the groundwater. (Gowen)

GROUNDWATER TABLE – The surface between the zone of saturation and the zone of aeration and includes the surface of an unconfined aquifer (Gowen)

GROUT – A fluid mixture of cement or bentonite with water of a consistency that can be forced through a pipe and placed as required. (GWW) It can be a sealant or an abandonment barrier material if it meets the requirements of the **Wells Regulation**.

GROUTING – The operation by which a sealant is placed in a well's annular space or abandonment barrier is placed in an abandoned well including its annular space.

HARDNESS – A property of water causing the formation of an insoluble residue when the water is used with soap. It is primarily caused by calcium and magnesium ions. (GWW)

HEAD (HYDRAULIC HEAD) – The energy contained in a mass of water that is produced by elevation, pressure, or velocity. (GWW)

HEAD Loss – That part of head energy which is lost because of friction as water flows. (GWW)

HETEROGENEOUS – Nonuniform in structure of composition throughout. (GWW)

HOLE STABILIZER –A steel casing, a concrete tile, other temporary structure or drilling fluid (mud) which prevents the formation from collapsing into the well during well construction.

HOMOGENEOUS – Uniform in structure or composition throughout. (GWW)

HYDRATION – The act by which a substance takes up water by absorption and/or adsorption.

HYDRAULIC CONDUCTIVITY – A measure of the ability of a fluid to flow through a porous medium determined by the size and shape of the pore spaces or fractures in the formation and their degree of interconnection and also by the viscosity of the fluid.

HYDRAULIC GRADIENT – The slope of the groundwater level or water table. It is the driving force of fluid flow in a porous medium. The hydraulic gradient indicates which direction groundwater will flow and how rapidly.

HYDROFRACING – see Hydrofracturing.

HYDROFRACTURING (HYDRAULIC FRACTURING) – The process whereby water is pumped under high pressure into a bedrock well to fracture and clean out the reservoir rock surrounding the well bore. It is used in an attempt to increase the yield of low producing water wells in bedrock where joint systems or fractures are poorly developed. It is also used in well development immediately after new well construction.

HYDROGEOLOGIST – A person who specializes in hydrogeology and, in Ontario, a person who also holds a licence under the *Professional Engineers Act* R.S.O 1990 c.P28 to practice as and use the title of a *Professional Engineer* or holds a certificate of registration under the *Professional Geoscientist Act,* 2000, S.O. 2000, c13 to practice as and use the title of *Professional Geoscientist*.

HYDROGEOLOGY – A discipline of geology dealing with the study of groundwater, with particular emphasis on the chemistry and movement of water.

HYDROLOGIC CYCLE – The continued circulation of water between the ocean, atmosphere and land.

IMPERMEABLE – Watertight, or not capable of being penetrated, as in the case of rock or soil not allowing the passage of water.

IMPERMEABLE LAYER – Layer of solid material, such as rock or clay, which does not allow water to easily pass through.

INERTIAL PUMP - A manual well pump with a one-way foot valve typically attached to polyethylene tubing.

This pump operates by moving the top of the tube up and down. This type of pump is commonly used in monitoring wells to sample the well water.

INFILTRATION – Flow of water from the land surface into the subsurface. The movement of water (typically from precipitation), or other liquid down through pores or fractures in soil and bedrock.

IN SITU – In its original place; unmoved; unexcavated; remaining in the subsurface.

INTERFERENCE (QUANTITY) – The condition occurring when the cone (area) of influence of a water well comes into contact with or overlaps that of a neighbouring well that are both pumping from the same aquifer or are located near each other. In some cases the pumping causes a well to go dry.

JETTING – Propulsion of water under high pressure into sandy aquifers to create a hole for the installation of a driven point well.

KELLY – Hollow steel bar that is the main section of drill string to which the power is directly transmitted from the rotary table of a drilling rig to rotate the drill pipe and bit or to rotate the bucket on a boring rig.

K-PACKER – A threaded metal device covered in neoprene, or other type of rubber, that is used to connect the top of the well screen to near the bottom of the casing. The device can be used to seal the annular space between two casings or between a casing and the open hole. A k-packer can be considered a suitable sealant in some cases.

LAMINAR FLOW – Water flow in which the stream lines remain distinct and in which the flow direction at every point remains unchanged with time. It is characteristic of the movement of groundwater through a well screen.

LEAKAGE – The flow of water from one hydrogeologic unit to another. It may be natural or through a structure like a well or other preferential pathway.

LOWER Explosive Limit (LEL) – The concentration of a gas in air above which the concentration of vapours is sufficient to support an explosion.

LOST CIRCULATION – The result of drilling fluid escaping from the hole into the formation by way of pores or fractures in the formation.

NATURALLY DEVELOPED WELL – A well in which the well screen is placed in direct contact with the aquifer materials and developed such that the fine native material is drawn through the well screen and the coarse material is graded against the outside of the screen forming a natural filter pack.

NOMINAL – Used to describe standard sizes for pipe from 3.2 mm to 305 mm (1/8 in to 12 in). The nominal size is specified on the basis of the inside diameter. Depending on the wall thickness, the inside diameter may be less than or greater than the number indicated.

OXIDATION – REDUCTION (REDOX) – A chemical reaction consisting of two half reactions. They are an oxidation reaction in which a substance loses (or donates) electrons and a reduction reaction in which a substance gains (or accepts) electrons.

PARTIAL PENETRATION – A condition where the intake portion of the well is less than the full thickness of the aquifer.

PACKER(S) – A tightly fitting device placed in a well to isolate or seal a portion of a well. Packers can be installed in pairs to seal the section of a well between two packers. In some cases only one packer will be placed to isolate the section of the well between the packer and the bottom of the well.

PATHOGEN – A disease causing microbial agent. Generally, any bacteria, viruses, protozoans or fungi that can cause disease in humans, plants or animals.

PEAK WATER DEMAND – The highest rate of water use each day. Well capacities or storage facilities should be designed to meet this demand.

PERCHED AQUIFER - It is considered a special case of an unconfined aquifer. It can occur wherever an impervious (or semi-impervious) layer of limited aerial extent is located between the regional water table of an unconfined aquifer and the ground surface.

PERCHED GROUNDWATER – Unconfined groundwater separated from an underlying main body of groundwater by a confining layer.

PERCOLATION– see Infiltration.

PERFORATIONS – Slits cut into the well casing to form a well screen allowing groundwater to enter the well. They may be located at more than one level, to coincide with water-bearing strata in the earth.

PERMEABILITY – The ability of an aquifer or water-bearing formation to allow water to pass through it; the capacity of an aquifer to permit the movement of water. It is also a measure of how easily water flows through a material. Often used as a synonym for hydraulic conductivity.

PH – A measure of the relative acidity or alkalinity of water. A pH of 7 is neutral. Values less than 7 are acidic and greater than 7 are basic (alkaline).

PIEZOMETRIC SURFACE – see Potentiometric Surface.

PITLESS ADAPTER – A metallic (usually brass) fitting that is attached to the casing below the frost line to connect the in-well drop pipe (waterline) to the buried horizontal pipe (waterline) leading to point of use. If properly installed, the connection will be watertight to the casing. It allows the

pipe to pass horizontally through the casing so that no pipe is exposed above ground where it could freeze. The device is designed to replace the need for well pits and pump houses.

POLYMER – A substance formed by the union of two or more molecules of the same kind linked end to end into another compound having the same elements in the same proportion but a higher molecular weight and different physical properties.

PORE SPACE – Small openings in a formation filled with air or water.

POROSITY – The ratio of voids or porous openings in overburden or bedrock to the total volume of the overburden and bedrock.

POTENTIOMETRIC SURFACE – A surface that represents the level to which groundwater in a confined aquifer would rise in a well when encountering the aquifer. If the hydraulic head varies significantly with depth in the aquifer, then there may be more than one potentiometric surface. The water table can be considered to be the potentiometric surface for an unconfined aquifer.

PRESSURE GROUTING – A process by which grout is confined within the hole or casing by the use of retaining plugs in packers, and by which sufficient pressure is applied to drive the grout slurry into the annular space or zone to be grouted.

PRESSURE HEAD – The height of a column of static fluid (water) which is necessary to develop a specific pressure. [Gowen]

PROFESSIONAL ENGINEER –an Engineer in good standing licensed pursuant to the *Professional Engineers Act*, RSO 1990, p. 28.

PROFESSIONAL GEOSCIENTIST – a Geoscientist in good standing registered pursuant to the *Professional Geoscientists Act*, 2000, p. 12.

PUMPING Test – An aquifer test that is conducted to determine aquifer or well characteristics.

PUMPING WATER LEVEL – The water level in the well during pumping (usually measured from the ground surface or the top of the well casing). For the purposes of the well record the pumping water level has to be measured from the ground surface.

RADIUS OF INFLUENCE – The distance from the centre of a well to the outermost point of the cone of depression where the drawdown approaches zero.

RAW WATER – Surface or groundwater that is available as a source of drinking water but has not received any treatment.

RECHARGE – The process by which an aquifer is replenished with water. This can also mean the quantity of water infiltrating from the surface and percolating to aquifers.

RECHARGE AREA – An area in an aquifer where there are downward components of hydraulic head. In this area, infiltration travels downward into the deeper sections of the aquifer.

RECIPROCATING PUMP – A pump where the motor sitting above the well moves a piston up and down inside a cylinder in the well casing. On the upstroke, water is pulled into the pipe. A check valve at the foot of the pipe prevents water from flowing out of the pipe on the downstroke. It works the same way as a hand pump.

RECOVERY RATE – Rate at which the groundwater level rises in the well after pumping stops.

RESIDUAL DRAWDOWN – The difference between the original static water level and the depth to the water level in a well at a given instant during the recovery period.

RISER – The pipe extending from the slots in the well screen to the well casing in a telescopic well screen. It is also sometimes referred to as the well casing or the drop pipe.

SAFETY ROPE – Nylon rope used to secure the pump in case of pipe breakage.

SATURATED – Pores in a medium filled with water.

SATURATED ZONE – The zone below and including the water table in which all pore spaces or fissures are totally filled with water. Also referred to as the phreatic zone.

SHEAR – see Shear Strength and Shear Stress

SHEAR STRENGTH – The maximum resistance of a soil or rock to shearing stresses. It can also refer to the measure of shear or gel properties of a drilling fluid or grout.

SHEAR STRESS – The component of stress which acts tangential to a plane through any given point in a body.

SHORE WELL - A hole in the ground located at or near the shore or bank of any surface water that is designed to take water only from surface water sources such as a lake or river. For further clarification, a hole is not considered a well as long as the hole does not encounter groundwater and is not subject to the requirements of the **Wells Regulation** or the licensing requirements in the *Ontario Water Resources Act*. Some holes close to surface water features which may have been designed to take surface water may also take groundwater. In this case the hole is considered a well under the *Ontario Water Resources Act* and the **Wells Regulation** requires the well owner to prevent the entry of surface water from entering the well.

SIEVE ANALYSIS – Determination of the particle-size distribution of a soil, sediment, or rock by measuring the percentage of the particles that will pass through standard sieves of various sizes.

SLUG TEST – A test carried out to determine in situ hydraulic conductivity by instantaneously adding a known water quantity (or solid object of known displacement) to a well and measuring the resulting recovery of the water level. Also known as a falling head test.

SPECIFIC CAPACITY –The yield of water per unit (metre or foot) of drawdown while pumping the well. Typically, specific capacity will decrease as pumping time or the pumping rate increase.

SPECIFIC GRAVITY – The weight of a particular volume of any substance compared to the weight of an equal volume of water at a reference temperature.

SPECIFIC STORAGE – The quantity of water released from or taken into storage per unit volume of a porous medium per unit change in head.

SPECIFIC YIELD – The ratio of the volume of yield of water by gravity drainage from bedrock or overburden (after being saturated) to the volume of the bedrock or overburden.

SPRING –A natural groundwater discharge on the land where the water table is higher than the ground surface. Pressure forces the water out of the land at a weak point, which creates the spring. For further clarification, if works are constructed around a spring or if equipment is installed for the collection or transmission of water, and the water is likely to be used for human consumption, then the spring is considered a well.

STRATA – Layers of deposited rock, overburden, etc. which are distinguishable from each other.

SUBMERSIBLE PUMP – Submersible pumps are long, narrow pumps that fit into the well and sit below the water level. They are connected to the surface by a plastic or steel pipe and a waterproof electrical cable. The water flow in the well provides cooling for the motor.

SURFACE WATER – Water that is on the earth's surface, such as streams, rivers, lakes or reservoirs.

SURFACTANT – A substance capable of reducing the surface tension of a liquid in which it is dissolved. Used in air-based drilling fluids to produce foam, and during well development to disaggregate clays.

SURGE BLOCK – see Surging

SURGING – Development technique used with cable tool and rotary drills utilizing a surge block. A surge block consists of two or more rubber disks sandwiched between steel plates. Up and down movement of the surge block in the well forces water to flow into and out of formation.

SUSTAINED YIELD – The rate at which groundwater can be withdrawn from an aquifer without long term depletion of the supply.

STABILIZER – see Collar.

TENSILE STRENGTH – The resistance of a material to a force tending to tear it apart.

TOTAL DISSOLVED SOLIDS (TDS) – Term that expresses the quantity (mass) of dissolved material in a sample of water typically expressed in milligrams per litre.

TRANSMISSIVITY – The rate at which groundwater can flow through an aquifer section of unit width under a unit hydraulic gradient. It is the average permeability of a section of the entire aquifer at a given location multiplied by the thickness of the formation.

UNCONFINED AQUIFER (WATER TABLE AQUIFER) – An aquifer confined only by the lower impermeable layer. Water usually saturates only part of the geologic unit and there is no upper confining layer. In an unconfined aquifer the water table is exposed to the atmosphere through openings in the overlying materials. In an unconfined aquifer, the cone of depression is a cone-shaped depression in the water table where the formation has actually been dewatered.

UNCONSOLIDATED FORMATIONS – Formations of materials that are loose (not lithified), such as sand, gravel, silt and clay.

UNDERREAMER - A wing on a drill bit that can allow a drill bit to swing out into the formation below the casing during drilling and retract into the casing when drilling is completed. [GWW]

UNSATURATED – Pores containing air or a mixture of air and water.

UNSATURATED ZONE – The zone above the water table in which soil pores or fissures are less than totally saturated. It is also called the vadose zone or the zone of aeration.

UPGRADIENT - An upward hydrologic slope. Wells that are upgradient of a source of contamination are less prone to receive the contaminants at elevated concentrations.

VISCOSITY – The property of a substance to offer internal resistance to flow. Specifically, the ratio of the shear stress to the rate of shear strain.

WATER TABLE –The top of the zone of saturation where the surface is not formed by a confining unit.

WATER TABLE AQUIFER – see Unconfined Aquifer.

WELLHEAD – The visible part of the well above the ground surface or above a floor.

Ontario Legislation

Subsection 1(1) and Sections 35 to 50 of:

Ontario Water Resources Act

R.S.O. 1990, CHAPTER O.40

Consolidation Period: From September 24, 2009 to the e-Laws currency date.

Note: January 1, 2010 has been named by proclamation as the day on which the amendments made by 2009, c. 19, s. 70 (1)-(4), (6), (8)-(10) come into force.

Note: July 1, 2011 has been named by proclamation as the day on which the amendments made by 2007, c. 7, Sched. 30, ss. 2 (2), 4 come into force.

Last amendment: 2009, c. 19, s. 70.

Interpretation

1. (1) In this Act,

“Agency” means the Ontario Clean Water Agency; (“Agence”)

“analyst” means an analyst appointed under the *Environmental Protection Act*; (“analyste”)

“Board” means the Ontario Municipal Board; (“Commission”)

“borrowings of the Commission” includes all loans raised by the Commission by the issue of debentures or otherwise and all advances from the Province to the Commission; (“emprunts de la Commission des ressources en eau”)

“Commission” means the Ontario Water Resources Commission; (“Commission des ressources en eau”)

“construction” includes reconstruction, improvement, extension, alteration, replacement and repairs, and “construct” has a corresponding meaning; (“construction”)

“cost” means,

(a) in relation to a project under an agreement entered into before the 1st day of April, 1974, the cost thereof as determined by the Minister of the Environment and includes interest during construction and such engineering fees and other charges and expenses in connection with construction as the Minister of the Environment may determine, and such proportion of discounts, commissions and other charges and expenses in respect of the issue of debentures by the Crown as the Minister of the Environment in his or her discretion may allocate to the project, or

(b) in relation to a project under an agreement entered into on or after the 1st day of April, 1974, the cost thereof as determined by the Minister of the Environment and includes such engineering fees and other charges and expenses in connection with construction as the Minister of the Environment may determine and such financing costs applicable to the project as the Minister of Finance may determine and the Minister of the Environment in his or her discretion may allocate to the project; (“coût”)

“Crown” means Her Majesty the Queen in right of Ontario; (“Couronne”)

“date of completion” of a project means the date that is certified by the Minister as being the date on which the project is completed to the extent necessary to enable the Minister to supply water or to receive, treat and dispose of sewage, as the case may be; (“date d’achèvement”)

“debentures” includes bonds, notes and other securities; (“débentures”)

“Director” means a Director appointed under section 5; (“directeur”)

“discharge”, when used as a verb, includes add, deposit, emit or leak and, when used as a noun, includes addition, deposit, emission or leak; (“rejet”, “rejeter”)

“document” includes a sound recording, videotape, film, photograph, chart, graph, map, plan, survey, book of account and information recorded or stored by means of any device; (“document”)

"environmental penalty" means a penalty imposed under section 106.1; ("pénalité environnementale")

"fiduciary" means an executor, administrator, administrator with the will annexed, trustee, guardian of property or attorney for property, but does not include a trustee in bankruptcy or trustee in bankruptcy representative; ("représentant fiduciaire")

"fiduciary representative" means, with respect to a fiduciary, an officer, director, employee or agent of the fiduciary, or a lawyer, consultant or other advisor of the fiduciary who is acting on behalf of the fiduciary; ("représentant d'un représentant fiduciaire")

"Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement of 2005" means the Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement dated December 13, 2005 and signed by the Premiers of Ontario and Quebec and the Governors of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin; ("Entente de 2005 sur les ressources en eaux durables du bassin des Grands Lacs et du fleuve Saint-Laurent")

"holder", when used in reference to a licence, permit or approval, means a person who is bound by the licence, permit or approval; ("titulaire")

"inspection" includes an audit, examination, survey, test and inquiry; ("inspection")

Note: On a day to be named by proclamation of the Lieutenant Governor, the French version of the definition of "inspection" is re-enacted. See: 2009, c. 19, ss. 70 (1), 73 (1).

"justice" means a provincial judge or a justice of the peace; ("juge")

"land" includes any estate, term, easement, right or interest in, to, over or affecting land; ("bien-fonds")

"Minister" means the Minister of the Environment; ("ministre")

"Ministry" means the Ministry of the Environment; ("ministère")

"municipality" includes a local board, as defined in the *Municipal Affairs Act*, and a board, commission or other local authority exercising any power with respect to municipal affairs or purposes, including school purposes, in an unorganized township or unsurveyed territory; ("municipalité")

"municipal representative" means, with respect to a municipality, an officer, employee or agent of the municipality, or a lawyer, consultant or other advisor of the municipality who is acting on behalf of the municipality; ("représentant municipal")

"natural environment" has the same meaning as in the *Environmental Protection Act;* ("environnement naturel")

"owner" means a municipality or person having authority to construct, maintain, operate, repair, improve or extend water works or sewage works; ("propriétaire")

"person" includes a municipality; ("personne")

"place" includes a building, structure, machine, vehicle or vessel; ("lieu")

"project" means water works or sewage works provided for in an agreement under section 63; ("ouvrage")

"Province" means the Province of Ontario; ("province")

"provincial officer" means a person who is designated under section 5; ("agent provincial")

"receiver" means a person who has been appointed to take or who has taken possession or control of property pursuant to a mortgage, hypothec, pledge, charge, lien, security interest, encumbrance or privilege or pursuant to an order of a court, and includes a receiver-manager and an interim receiver; ("séquestre")

"receiver representative" means, with respect to a receiver, an officer, director, employee or agent of the receiver, or a lawyer, consultant or other advisor of the receiver who is acting on behalf of the receiver; ("représentant d'un séquestre")

"regulated person" means,

(a) a person who belongs to a class of persons prescribed by the regulations and who holds or is required to hold,

(i) an approval, licence or permit under this Act, or

(ii) a certificate of approval, provisional certificate of approval, certificate of property use, licence or permit under the *Environmental Protection Act*, or

(b) a corporation that belongs to a class of corporations prescribed by the regulations; ("personne réglementée")

"regulations" means the regulations made under this Act; ("règlements")

"secured creditor" means a person who holds a mortgage, hypothec, pledge, charge, lien, security interest, encumbrance or privilege on or against property, but does not include a person who has taken possession or control of the property; ("créancier garanti")

"secured creditor representative" means, with respect to a secured creditor, an officer, director, employee or agent of the secured creditor, or a lawyer, consultant or other advisor of the secured creditor who is acting on behalf of the secured creditor; ("représentant d'un créancier garanti")

"sewage" includes drainage, storm water, commercial wastes and industrial wastes and such other matter or substance as is specified by the regulations; ("eaux d'égout")

"sewage works" means any works for the collection, transmission, treatment and disposal of sewage or any part of such works, but does not include plumbing to which the *Building Code Act, 1992* applies; ("station d'épuration des eaux d'égout")

"Tribunal" means the Environmental Review Tribunal; ("Tribunal")

"trustee in bankruptcy representative" means, with respect to a trustee in bankruptcy, an officer, director, employee or agent of the trustee in bankruptcy, or a lawyer, consultant or other advisor of the trustee in bankruptcy who is acting on behalf of the trustee in bankruptcy; ("représentant d'un syndic de faillite")

"waters" means a well, lake, river, pond, spring, stream, reservoir, artificial watercourse, intermittent watercourse, ground water or other water or watercourse; ("eaux")

"water distribution system" means a part of a water treatment or distribution system that distributes water, if that part of the system includes one or more water works; ("système de distribution de l'eau")

"water treatment or distribution system" means a system for collecting, producing, treating, storing, supplying or distributing water that includes one or more water works; ("système de traitement ou de distribution de l'eau")

"water works" means any works for the collection, production, treatment, storage, supply and distribution of water, or any part of such works, but does not include plumbing to which the *Building Code Act, 1992* applies; ("station de purification de l'eau")

"well" means a hole made in the ground to locate or to obtain ground water or to test or to obtain information in respect of ground water or an aquifer, and includes a spring around or in which works are made or equipment is installed for collection or transmission of water and that is or is likely to be used as a source of water for human consumption. ("puits") R.S.O. 1990, c. O.40, s. 1; 1992, c. 23, s. 39 (1); 1993, c. 23, s. 73 (1, 2); 1998, c. 35, s. 44; 2000, c. 22, s. 2 (1); 2000, c. 26, Sched. E, s. 5; 2000, c. 26, Sched. F, s. 13 (1, 2); 2001, c. 9, Sched. G, s. 6 (1-5); 2001, c. 17, s. 5 (1); 2002, c. 17, Sched. F, Table; 2005, c. 12, s. 2 (1, 2); 2007, c. 12, s. 1 (2).

WELLS

Interpretation re: wells, ss. 35-50, 75 (2)

35. (1) In this section and in sections 36 to 50 and subsection 75 (2),

"construct", when used with respect to a well, means bore, dig, drill or otherwise make, extend or alter; ("construire")

"licensee" means the holder of a well contractor licence or a well technician licence, as the case requires; ("titulaire d'une licence")

"well construction permit" means a permit referred to in section 36; ("permis de construction de puits")

"well contractor licence" means a licence referred to in section 39; ("licence d'entrepreneur en construction de puits")

"well technician licence" means a licence referred to in section 43. ("licence de technicien en construction de puits") R.S.O. 1990, c. O.40, s. 35 (1); 2000, c. 26, Sched. F, s. 13 (7); 2001, c. 9, Sched. G, s. 6 (7, 8); 2007, c. 12, s. 1 (13).

Interpretation: works or equipment

(2) For the purposes of this section, sections 36 to 50 and subsection 75 (2), installing equipment in or connected to a well shall be deemed to be the constructing of a well. R.S.O. 1990, c. O.40, s. 35 (2); 2001, c. 9, Sched. G, s. 6 (9).

Permit required to construct well in designated area

36. Subject to section 47.3 of the *Environmental Protection Act*, no person shall construct a well in an area designated by the regulations except under and in accordance with a well construction permit issued by a Director. R.S.O. 1990, c. O.40, s. 36; 2009, c. 12, Sched. H, s. 2.

Issuance of well construction permit

37. Subject to section 38, any person who applies in accordance with this Act and the regulations for a well construction permit and who pays the prescribed fee is entitled to be issued the permit. R.S.O. 1990, c. O.40, s. 37.

Note: On a day to be named by proclamation of the Lieutenant Governor, section 37 is amended by the Statutes of Ontario, 2001, chapter 9, Schedule G, subsection 6 (10) by striking out "the prescribed fee" and substituting "the required fee". See: 2001, c. 9, Sched. G, ss. 6 (10), 8 (4).

Grounds for refusal to issue, etc., well construction permit

38. A Director may refuse to issue or to renew or may revoke a well construction permit, may impose terms and conditions in issuing or renewing or after issuing or renewing a well construction permit and may alter the terms and conditions of a well construction permit that has been issued or renewed where the Director is of the opinion, upon reasonable and probable grounds, that,

(a) the proposed well or its operation would contravene this Act or the regulations or any other Act or a regulation under any other Act;

(b) there is or is likely to be danger to the health or safety of any person;

(c) there is or is likely to be harm or material discomfort to any person;

(d) there is or is likely to be impairment of the quality of any air, land or water for any use that is being or is likely to be made of it;

(e) there is or is likely to be reduction of the quantity of water available for any use that is being or is likely to be made of it;

(f) there is or is likely to be injury or damage to any property or to plant or animal life;

(g) any property or plant or animal life is or is likely to be rendered, directly or indirectly, unfit for use by people;

(h) there is or is likely to be loss of enjoyment of the normal use of any property;

(i) there is or is likely to be interference with the normal conduct of any business; or

(j) there is a breach of a term or condition of the permit. R.S.O. 1990, c. O.40, s. 38.

Well contractor licence required

39. No person shall engage in the business of constructing wells except under and in accordance with a well contractor licence issued by a Director or unless exempt under the regulations. R.S.O. 1990, c. O.40, s. 39.

Issuance of well contractor licence

40. Subject to sections 41 and 42, a Director shall issue a well contractor licence to any applicant therefor who is qualified for the licence under sections 35 to 50 and the regulations and has paid the prescribed fee. R.S.O. 1990, c. O.40, s. 40; 2001, c. 9, Sched. G, s. 6 (11).

Note: On a day to be named by proclamation of the Lieutenant Governor, section 40 is amended by the Statutes of Ontario, 2001, chapter 9, Schedule G, subsection 6 (12) by striking out "the prescribed fee" at the end and substituting "the required fee". See: 2001, c. 9, Sched. G, ss. 6 (12), 8 (4).

Grounds for refusal to issue well contractor licence

41. A Director may refuse to issue a well contractor licence where the Director is of the opinion, upon reasonable and probable grounds, that,

(a) the past conduct of the applicant or, where the applicant is a corporation, of its officers or directors affords grounds for belief that the business of constructing wells will not be operated in accordance with the law and with honesty and integrity;

(b) the applicant or, where the applicant is a corporation, its officers or directors are not competent to engage in the business of constructing wells;

(c) the applicant is not in a position to observe or carry out the provisions of sections 35 to 50, the regulations and the licence; or

(d) the applicant or, where the applicant is a corporation, its officers or directors have been grossly negligent in carrying on the business of constructing wells under the authority of a licence issued under section 40 or a predecessor of that section. R.S.O. 1990, c. O.40, s. 41; 2001, c. 9, Sched. G, s. 6 (13).

Grounds for revocation, etc., of well contractor licence

42. A Director may revoke or suspend or may refuse to renew a well contractor licence where the Director is of the opinion, upon reasonable and probable grounds, that,

(a) any person has made a false statement in any material part of the application for the licence or a renewal thereof or of any report, document or other information required to be furnished by this Act or the regulations or any other Act or a regulation under any other Act that relates to wells;

(b) the past conduct of the licensee or, where the licensee is a corporation, of its officers or directors affords grounds for belief that the business of constructing wells has not been operated or will not be operated in accordance with the law and with honesty and integrity;

(c) the licensee is in contravention of sections 35 to 50 or the regulations;

(d) a change in the officers or directors of a corporation that is a licensee affords grounds for refusing to issue a licence under clause 41 (a), (b) or (d);

(e) the services that can be provided by the licensee have been misrepresented;

(f) the licensee is not competent to carry on or has been grossly negligent in carrying on the business of constructing wells; or

(g) the licensee is not in a position to observe or carry out the provisions of sections 35 to 50, the regulations or the licence. R.S.O. 1990, c. O.40, s. 42; 2001, c. 9, Sched. G, s. 6 (14, 15).

Well technician

43. (1) No person shall work at the construction of wells except under and in accordance with a well technician licence of a class prescribed by the regulations or unless exempt under the regulations. R.S.O. 1990, c. O.40, s. 43 (1); 2001, c. 9, Sched. G, s. 6 (16).

Proof of employment

(2) For the purposes of this section, proof of work on one occasion at the construction of a well is sufficient to establish work at the construction of wells. R.S.O. 1990, c. O.40, s. 43 (2).

Exception

(3) Subsection (1) does not apply,

(a) to a person who works at the construction of a well on land owned by the person or by a member of the person’s household; or

(b) to a person who works without remuneration for another person at the construction of a well on land owned by the other person or by a member of the other person’s household. R.S.O. 1990, c. O.40, s. 43 (3).

Issuance of well technician licence

44. Subject to sections 45 and 46, a Director shall issue a well technician licence of a class prescribed by the regulations to any applicant therefor who is qualified for the licence under sections 35 to 50 and the regulations and has paid the prescribed fee. R.S.O. 1990, c. O.40, s. 44; 2001, c. 9, Sched. G, s. 6 (17).

Note: On a day to be named by proclamation of the Lieutenant Governor, section 44 is amended by the Statutes of Ontario, 2001, chapter 9, Schedule G, subsection 6 (18) by striking out "the prescribed fee" at the end and substituting "the required fee". See: 2001, c. 9, Sched. G, ss. 6 (18), 8 (4).

Grounds for refusal to issue well technician licence

45. A Director may refuse to issue a well technician licence where the Director is of the opinion, upon reasonable and probable grounds, that the applicant is not competent to carry on the activities that would be authorized by the licence. R.S.O. 1990, c. O.40, s. 45.

Grounds for refusal to renew, etc., well technician licence

46. A Director may revoke or suspend or may refuse to renew a well technician licence where the Director is of the opinion, upon reasonable and probable grounds, that,

(a) any person has made a false statement in any material part of the application for the licence or a renewal thereof or of any report, document or other information required to be furnished by this Act or the regulations or any other Act or a regulation under any other Act that applies to the construction of wells;

(b) the licensee is in contravention of sections 35 to 50 or the regulations; or

(c) the licensee is not competent to carry on or has been grossly negligent in carrying on the activities that are authorized by the licence. R.S.O. 1990, c. O.40, s. 46; 2001, c. 9, Sched. G, s. 6 (19).

Review, refusal to issue, etc., well permit or licences

Notice of proposal to refuse to issue, etc.

47. (1) Where a Director proposes,

(a) to refuse to issue or renew a well construction permit;

(b) to revoke a well construction permit;

(c) to impose terms and conditions in a well construction permit;

(d) to alter the terms and conditions in a well construction permit;

(e) to refuse to issue or renew a well contractor licence or a well technician licence; or

(f) to revoke or suspend a well contractor licence or a well technician licence,

the Director shall serve notice of the proposal, together with written reasons therefor, on the applicant, permittee or licensee, and the applicant, permittee or licensee may, by written notice served upon the Director and the Tribunal within fifteen days after the service of the notice of the Director, require a hearing by the Tribunal. R.S.O. 1990, c. O.40, s. 47 (1); 2000, c. 26, Sched. F, s. 13 (13).

Powers of Tribunal where hearing

(2) Where an applicant, permittee or licensee requires a hearing by the Tribunal in accordance with subsection (1), the Tribunal shall appoint a time and place for and hold the hearing and may by order direct the Director to carry out the proposal or refrain from carrying out the proposal and to take such action as the Tribunal considers the Director ought to take in accordance with sections 35 to 50 and the regulations, and for such purposes the Tribunal may substitute its opinion for that of the

Director. R.S.O. 1990, c. O.40, s. 47 (2); 2000, c. 26, Sched. F, s. 13 (13); 2001, c. 9, Sched. G, s. 6 (20).

Parties

(3) The applicant, permittee or licensee, the Director and any other persons specified by the Tribunal are parties to the hearing. R.S.O. 1990, c. O.40, s. 47 (3); 2000, c. 26, Sched. F, s. 13 (13).

Extension of time for requiring hearing

(4) The Tribunal shall extend the time for the giving of notice requiring a hearing by an applicant, permittee or licensee referred to in subsection (1), either before or after the expiration of such time, where it is satisfied that there are reasonable grounds for granting the extension and that there are apparent grounds for granting relief to the applicant, permittee or licensee referred to in subsection (1), and the Tribunal may give such directions as it considers proper consequent upon the extension. R.S.O. 1990, c. O.40, s. 47 (4); 2000, c. 26, Sched. F, s. 13 (13).

Notice of hearing

(5) The Tribunal shall give to the applicant, permittee or licensee a reasonable opportunity to show or to achieve compliance before the hearing with all lawful requirements for the issue or retention of the permit or licence or to take such action as will preclude the necessity for imposing or altering terms or conditions in the permit. R.S.O. 1990, c. O.40, s. 47 (5); 1994, c. 27, s. 116; 2000, c. 26, Sched. F, s. 13 (13).

Examination of documentary evidence

(6) An applicant, permittee or licensee who is a party to proceedings under this section shall be afforded an opportunity to examine before the hearing any written or documentary evidence that will be produced or any report the contents of which will be given in evidence at the hearing. R.S.O. 1990, c. O.40, s. 47 (6).

(7) Repealed: 1997, c. 37, s. 4.

Findings of fact

(8) The findings of fact of the Tribunal pursuant to a hearing shall be based exclusively on evidence admissible or matters that may be noticed under sections 15 and 16 of the *Statutory Powers Procedure Act*. R.S.O. 1990, c. O.40, s. 47 (8); 2000, c. 26, Sched. F, s. 13 (13).

Release of documentary evidence

(9) Documents and things put in evidence at the hearing shall, upon the request of the person who produced them, be released to the person by the Tribunal within a reasonable time after the matter in issue has been finally determined. R.S.O. 1990, c. O.40, s. 47 (9); 2000, c. 26, Sched. F, s. 13 (13).

Appeal to court

(10) Any party to proceedings before the Tribunal under this section may appeal from its decision on a question of law to the Divisional Court in accordance with the rules of court. R.S.O. 1990, c. O.40, s. 47 (10); 2000, c. 26, Sched. F, s. 13 (13).

(11) Repealed: 1997, c. 37, s. 4.

Appeal to Minister

(12) Any party to a hearing before the Tribunal, within thirty days after receipt of the decision of the Tribunal or within thirty days after final disposition of an appeal, if any, under subsection (10), may appeal in writing to the Minister on any matter other than a question of law and the Minister shall confirm, alter or revoke the decision of the Tribunal as to the matter in appeal as he or she considers in the public interest. R.S.O. 1990, c. O.40, s. 47 (12); 2000, c. 26, Sched. F, s. 13 (13).

Power of Director where no hearing

(13) Where an applicant, permittee or licensee does not require a hearing by the Tribunal under this section, the Director may carry out the proposal stated in the notice under subsection (1). R.S.O. 1990, c. O.40, s. 47 (13); 2000, c. 26, Sched. F, s. 13 (13).

Where hearing required

(14) Where a hearing by the Tribunal is required under this section, the Director, subject to section 48, shall not carry out the proposal until final disposition of the hearing and any appeal. R.S.O. 1990, c. O.40, s. 47 (14); 2000, c. 26, Sched. F, s. 13 (13).

Interim order, refusal to issue, etc., well permit or licences

48. (1) Upon application by the Director and subject to subsection (4), the Tribunal may order that a proposal under section 47 may be carried out at once although a hearing is or may be required under that section or that the applicant, permittee or licensee fails to appear on the hearing of the application or the Tribunal may make a decision not to make such an order. R.S.O. 1990, c. O.40, s. 48 (1); 2000, c. 26, Sched. F, s. 13 (13).

Notice

(2) An application under subsection (1) must be made on not less than three full days notice to the applicant, permittee or licensee. R.S.O. 1990, c. O.40, s. 48 (2).

Appearance by respondent

(3) The respondent to an application under subsection (1) may,

(a) appear in person or by a person authorized under the *Law Society Act* to represent the respondent at the hearing of the application; or

(b) make submissions to the Tribunal by telephone or other means for consideration at the hearing. 2006, c. 21, Sched. C, s. 125 (1).

Grounds for order

(4) The Tribunal may make an order under subsection (1) only where the Tribunal is satisfied that the order is necessary for the protection of the public or of any member of the public. R.S.O. 1990, c. O.40, s. 48 (4); 2000, c. 26, Sched. F, s. 13 (13).

Order may be subject to conditions

(5) An order or a decision under subsection (1) may be made subject to such conditions as the Tribunal considers appropriate. R.S.O. 1990, c. O.40, s. 48 (5); 2000, c. 26, Sched. F, s. 13 (13).

When order terminates

(6) An order under subsection (1) and a proposal carried out in accordance with the order are effective until final disposition of the hearing and any appeal. R.S.O. 1990, c. O.40, s. 48 (6).

Expiry of well permit or licences

49. (1) Every well construction permit, every well contractor licence and every well technician licence expires on the 31st day of March in the year next following the year of its issue or renewal. R.S.O. 1990, c. O.40, s. 49 (1).

Continuation of licence pending renewal

(2) Where a licensee has applied for a renewal of his, her or its licence and paid the prescribed fee before expiry of the licence, the licence shall be deemed to continue,

Note: On a day to be named by proclamation of the Lieutenant Governor, subsection (2) is amended by the Statutes of Ontario, 2001, chapter 9, Schedule G, subsection 6 (21) by striking out "the prescribed fee" and substituting "the required fee". See: 2001, c. 9, Sched. G, ss. 6 (21), 8 (4).

(a) until the renewal is granted; or

(b) where the licensee is served with notice that the Director proposes to refuse to grant the renewal, until the time for serving notice requiring a hearing by the Tribunal has expired and, where a hearing is required, until final disposition of the hearing and any appeal. R.S.O. 1990, c. O.40, s. 49 (2); 2000, c. 26, Sched. F, s. 13 (13).

Application of s. 48 (1)

(3) Subsection (2) does not apply where an order is made under subsection 48 (1). R.S.O. 1990, c. O.40, s. 49 (3).

Transfer of well permit or licences

50. A well construction permit, well contractor licence or well technician licence is not transferable. R.S.O. 1990, c. O.40, s. 50.

51. Repealed: 2001, c. 9, Sched. G, s. 6 (22).

52. Repealed: 2007, c. 10, Sched. D, s. 2 (6).

The Wells Regulation

Français

Ontario Water Resources Act

R.R.O. 1990, REGULATION 903

WELLS

Consolidation Period: From October 8, 2009 to the e-Laws currency date.

Last amendment: O. Reg. 389/09.

This is the English version of a bilingual regulation.

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Definitions

1. (1) In this Regulation,

"air vent" means an outlet at the upper end of the casing that allows for equalization of air pressure between the inside of the casing and the atmosphere and for the release of gases from the well; ("évent")

"annular space" means an open space between a casing or well screen and the side of a well, and includes space between overlapping casings within the well; ("espace annulaire")

"aquifer" means a water-bearing formation that is capable of transmitting water in sufficient quantities to serve as a source of water supply; ("formation aquifère")

"assistant well technician" means a person who works at the construction of wells as an employee or agent of the holder of a well contractor licence under the supervision of the holder of a well technician licence; ("aide-technicien en construction de puits")

"ASTM" means ASTM International; ("ASTM")

"AWWA" means the American Water Works Association; ("AWWA")

"bedrock" means,

(a) the solid rock underlying unconsolidated material such as gravel, sand, silt and clay, or

(b) solid rock at the ground surface; ("roche-mère")

“bentonite” means a commercially produced sealing material to be used in well construction or abandonment that,

(a) consists of more than 50 per cent sodium montmorillonite by weight,

(b) has the ability to swell in the presence of water,

(c) does not provide nutrients for bacteria, and

(d) does not impair the quality of water with which it comes in contact; (“bentonite”)

“casing” means pipe, tubing or other material installed in a well to support its sides, but does not include a well screen; (“tubage”)

“chlorinated” means disinfected with free chlorine residual; (“chloré”)

“dewatering well” means a well that is not used or intended for use as a source of water for agriculture or human consumption and that is made,

(a) to lower or control the level of ground water in the area of the well, or

(b) to remove materials that may be in the ground water; (“puits d’exhaure”)

“flowing well” means a well that has a static water level above the ground surface; (“puits jaillissant”)

“mineralized water” means water containing in excess of 6,000 milligrams per litre total dissolved solids or 500 milligrams per litre chlorides or 500 milligrams per litre sulphates; (“eau minéralisée”)

“minor alteration” means, with respect to a well,

(a) routine repair or maintenance,

(b) the installation of monitoring, sampling or testing equipment, other than equipment used to test the yield of the well or the aquifer,

(c) the installation of a pump in a test hole, or

(d) the installation of a well cap or watertight well cover; (“modification mineure”)

“overburden” means unconsolidated material overlying bedrock; (“couverture”)

“pump” includes associated pumping equipment; (“pompe”)

“sealant” means,

(a) a slurry consisting of clean water and at least 20 per cent bentonite solids by weight, or

(b) other material that is equivalent to a slurry described in clause (a) with respect to the ability to form a permanent watertight barrier; (“matériau d’étanchéité”)

“static water level” means the level attained by water at equilibrium in a well when no water is being taken from the well; (“niveau hydrostatique”)

“subsurface formation” includes an aquifer; (“formation souterraine”)

"suitable sealant" means a sealant that is compatible with the quality of the water found in the well; ("matériau d'étanchéité approprié")

"test hole" means a well that,

(a) is made to test or to obtain information in respect of ground water or an aquifer, and

(b) is not used or intended for use as a source of water for agriculture or human consumption; ("trou d'essai")

"tremie pipe" means a pipe or tube with an inner diameter that is at least three times the diameter of the largest particle of material to pass through it and that is used to conduct material to the bottom of a hole, including a hole containing standing water; ("tuyau à trémie")

"well cluster" means a group of wells for which the person constructing the wells may complete one well record under subsection 16.4 (1); ("groupe de puits")

"well owner" means the owner of land upon which a well is situated and includes a tenant or lessee of the land and a well purchaser; ("propriétaire de puits")

"well purchaser" means a person who enters into a contract for the construction of a well with a person who is engaged in the business of constructing wells; ("acheteur de puits")

"well record" means a form supplied by the Ministry for recording information about a well during construction or abandonment of the well; ("registre de puits")

"well screen" means perforated pipe or tubing, unsealed concrete tiles or other material installed in a well to filter out particulate matter and form the water intake zone. ("filtre de puits") R.R.O. 1990, Reg. 903, s. 1; O. Reg. 128/03, s. 1; O. Reg. 372/07, s. 1 (1-8).

(2) For the purposes of this Regulation,

(a) a person is a person constructing a well if the person is a well technician or other individual who works at the construction of the well; and

(b) a well purchaser is not a person constructing a well. O. Reg. 372/07, s. 1 (9).

(3) For the purposes of this Regulation, a well's structural stage is complete on the day on which the well is capable of being used for the purpose for which it was constructed but for,

(a) compliance with section 15;

(b) the installation of a pump; or

(c) any alterations necessary to accommodate pumping, monitoring, sampling, testing or water treatment equipment. O. Reg. 372/07, s. 1 (9).

EXEMPTIONS

1.0.1 Sections 36 to 50 of the Act and this Regulation do not apply to any of the following that is a well:

1. A pond.

2. A reservoir.

3. A lagoon.

4. An artificial wetland.

5. A canal.

6. A trench.

7. A tile drain.

8. A wick drain.

9. A ditch. O. Reg. 372/07, s. 2.

1.0.2 Sections 36 to 50 of the Act and this Regulation do not apply to any of the following activities that are part of the construction of a well:

1. Inspecting the well using equipment that is not left unattended in the well.

2. Monitoring, sampling or testing the well using equipment that,

    i. is not used to test the yield of the well or the aquifer, and is not left unattended in the well, or

    ii. is not used to test the yield of the well or the aquifer, and was previously installed in the well.

3. Installing equipment for monitoring, sampling or testing a test hole or dewatering well, unless,

    i. the installation of the equipment involves an alteration of the well, other than notching the top of the casing, or

    ii. the equipment is used to test the yield of the well or the aquifer. O. Reg. 372/07, s. 2.

1.0.3 Section 43 of the Act does not apply to the following persons when they do anything referred to in paragraph 5 of subsection 5 (1) for a person who holds a well contractor licence:

1. Persons who hold a licence, limited licence or temporary licence under the *Professional Engineers Act*.

2. Persons who hold a certificate of registration under the *Professional Geoscientists Act, 2000* and who are practising members, temporary members or limited members of the Association of Professional Geoscientists of Ontario.

3. Persons who are registered under subsection 8 (2) of the *Ontario Association of Certified Engineering Technicians and Technologists Act, 1998*, being chapter Pr7, and who are ordinary members of the Association continued under that Act. O. Reg. 372/07, s. 2.

SHALLOW WORKS

1.1 (1) A test hole or dewatering well that is made to a depth of not more than 3.0 metres below the ground surface is exempt from sections 36 to 50 of the Act and from this Regulation, unless,

(a) it is constructed in a contaminated area;

(b) it is constructed in an area with conditions likely to result in flowing wells; or

(c) it penetrates through a formation that is not an aquifer. O. Reg. 128/03, s. 2.

(2) Despite subsection (1), a person who constructs a test hole or dewatering well described in that subsection shall ensure that,

(a) the major horizons of soil are excavated separately, stored separately, kept free from contamination and, when the test hole or dewatering well is no longer being used or maintained for future use as a well, backfilled in the same relative positions that they originally occupied; or

(b) when the test hole or dewatering well is no longer being used or maintained for future use as a well, it is backfilled with commercially produced dry bentonite sealing material or other suitable sealant, or with clean, uncontaminated soil that has a grain size that is the same as or finer than the soil that was originally excavated. O. Reg. 372/07, s. 3 (1).

(3) If it becomes apparent during construction, use or abandonment of a test hole or dewatering well that subsection (1) does not apply, the person who caused it to be constructed shall, unless subsection (4) applies, retain the services of the holder of a well contractor licence. O. Reg. 128/03, s. 2.

(4) The well owner shall retain the services of the holder of a well contractor licence if,

(a) the structural stage of a test hole or dewatering well is complete;

(b) the well owner has assumed control over the operation of the test hole or dewatering well; and

(c) it becomes apparent during use or abandonment of the test hole or dewatering well that subsection (1) does not apply. O. Reg. 372/07, s. 3 (2).

(5) The holder of a well contractor licence who is retained under subsection (3) or (4) shall ensure compliance with the Act, this Regulation and the *Environmental Protection Act*. O. Reg. 128/03, s. 2.

(6) Subsections (3) and (4) do not apply if the person who would otherwise be required to retain the services of the holder of a well contractor licence has an employee who is the holder of a well technician licence and who ensures compliance with the Act, this Regulation and the *Environmental Protection Act*. O. Reg. 128/03, s. 2.

WELL CONTRACTOR LICENCE

2. (1) An application for issuance of a well contractor licence shall be on a form supplied by the Ministry and shall be submitted along with the required fee. O. Reg. 128/03, s. 3.

(2) An application for renewal of a well contractor licence shall be on a form supplied by the Ministry and shall be submitted along with the required fee. O. Reg. 128/03, s. 3.

(3) If the applicant is a corporation or partnership, the application shall be completed and signed by the official representatives referred to in paragraph 1 of section 4. O. Reg. 128/03, s. 3.

3. (1) It is a requirement that an applicant for a well contractor licence or renewal thereof or, where the applicant is a partnership or a corporation, a partner or director thereof, be eighteen years of age or older. R.R.O. 1990, Reg. 903, s. 3 (1).

(2) An applicant for a well contractor licence or renewal thereof shall submit such information and material as the Director may reasonably require to satisfy the Director as to the character, qualifications and financial responsibility of the applicant or its directors and officers. R.R.O. 1990, Reg. 903, s. 3 (2).

(3) Every holder of a well contractor licence shall notify the Director in writing of any change in the information submitted under section 2 or subsection (2) within 10 days after the date of the change. O. Reg. 128/03, s. 4.

4. The following are prescribed as conditions attaching to every well contractor licence:

1. If the licensee is a corporation or partnership, it shall ensure that,

   i. at least one director, officer or partner is designated as the official representative of the licensee at all times, and

   ii. the official representatives have been assigned the responsibility of ensuring that the Act and this Regulation are complied with.

2. The licensee shall maintain insurance in a form approved by the Superintendent of Financial Services of the Province of Ontario for every well construction business carried on by the licensee, with respect to the liability of the licensee and the licensee's employees and agents arising out of the well construction business,

   i. in an amount not less than $2,000,000 for property damage arising out of any one incident, and

   ii. in an amount of not less than $2,000,000 for the death of or bodily injury to any person not an employee of the licensee, for each such person,

   but the contract of insurance may,

   iii. limit the insurer's liability under the contract of insurance arising out of any one incident to $5,000,000, and

   iv. provide that the insured shall be responsible for a stated amount, up to $1,000, for each claim for which coverage is required.

3. The licensee shall not do work or cause any work to be done with respect to the construction of wells except by or under the supervision of,

   i. the licensee, if the licensee is also the holder of a well technician licence acting within the authority granted by his or her well technician licence,

   ii. a partner of the licensee, if the licensee is a partnership and the partner is the holder of a well technician licence acting within the authority granted by his or her well technician licence,

iii. an officer or director of the licensee, if the licensee is a corporation and the officer or director is the holder of a well technician licence acting within the authority granted by his or her well technician licence,

iv. an employee or agent of the licensee, if the employee or agent is the holder of a well technician licence acting within the authority granted by his or her well technician licence, or

v. if the work only involves things referred to in paragraph 5 of subsection 5 (1), a person referred to in paragraph 1, 2 or 3 of section 1.0.3.

4. Revoked: O. Reg. 128/03, s. 5 (2).

5. The licensee shall comply and shall ensure that employees and agents comply with the requirements of the Act and this Regulation. R.R.O. 1990, Reg. 903, s. 4; O. Reg. 128/03, s. 5; O. Reg. 372/07, s. 4.

WELL TECHNICIAN LICENCE

5. (1) The following classes of well technician licence are prescribed:

1. Well Drilling being a licence authorizing the holder to construct and supervise the construction of wells by means of well drilling equipment including,

   i. rotary drilling equipment (standard, reverse, air, mud and air percussion),

   ii. cable tool (churn and percussion), and

   iii. diamond drilling equipment.

2. Well Digging and Boring being a licence authorizing the holder to construct and supervise the construction of wells by means of digging with non-powered equipment or with a back-hoe or power shovel and by means of boring or augering equipment.

3. Other Well Construction being a licence authorizing the holder to construct and supervise the construction of wells, or a type of well described in the licence, by only the methods or equipment specified in the licence.

4. Pump Installation being a licence authorizing the holder to install and supervise the installation of pumps in or connected to wells.

5. Monitoring, Sampling, Testing and Non-Powered Construction being a licence authorizing the holder to,

   i. install and supervise the installation of monitoring, sampling or testing equipment in a well, other than equipment used to test the yield of the well or the aquifer,

   ii. install and supervise the installation of pumps in a test hole or dewatering well for monitoring, sampling or testing purposes,

   iii. construct and supervise the construction of test holes and dewatering wells by any method that does not use powered equipment. R.R.O. 1990, Reg. 903, s. 5 (1); O. Reg. 128/03, s. 6 (1); O. Reg. 372/07, s. 5 (1, 2).

(1.1) A licence described in paragraph 1 or 2 of subsection (1),

(a) does not authorize the holder to do anything referred to in paragraph 4 or subparagraph 5 i or ii of subsection (1); and

(b) authorizes the holder to do anything referred to in subparagraph 5 iii of subsection (1). O. Reg. 372/07, s. 5 (3).

(1.2) A licence described in paragraph 3 of subsection (1) only authorizes the holder to do what is specified in the licence. O. Reg. 372/07, s. 5 (3).

(1.3) A licence described in paragraph 4 of subsection (1) authorizes the holder to do anything referred to in subparagraphs 5 i and ii of subsection (1). O. Reg. 372/07, s. 5 (3).

(2) An application for a well technician licence shall be on a form supplied by the Ministry and shall be submitted along with the required fee. O. Reg. 128/03, s. 6 (2).

(3) An application for renewal of a well technician licence shall be on a form supplied by the Ministry and shall be submitted along with the required fee. O. Reg. 128/03, s. 6 (2).

(4)-(8) Revoked: O. Reg. 128/03, s. 6 (2).

6. (1) It is a requirement that an applicant for a well technician licence be eighteen years of age or older. R.R.O. 1990, Reg. 903, s. 6 (1).

(2) An applicant for a well technician licence or renewal thereof shall submit such information and material as the Director may reasonably require to be satisfied as to the character, qualifications and ability of the applicant. R.R.O. 1990, Reg. 903, s. 6 (2); O. Reg. 372/07, s. 6 (1).

(3) The following are prescribed as qualifications for an applicant for a class of well technician licence described in paragraph 1, 2, 3 or 4 of subsection 5 (1):

1. Successful completion of a course of study, of at least 30 hours, that is approved by the Director for the class of well technician licence applied for.
2. Four thousand hours of work experience helping at or doing the activity that would be authorized by the licence applied for, or a combination of work experience and other qualifications that the Director considers equivalent. O. Reg. 372/07, s. 6 (2).

(3.1) The following are prescribed as qualifications for an applicant for the class of well technician licence described in paragraph 5 of subsection 5 (1):

1. In the case of an applicant referred to in subsection (3.2),

   i. successful completion of a course of study, of at least 15 hours, that is approved by the Director for the class of well technician licence described in paragraph 5 of subsection 5 (1), and

   ii. 500 hours of work experience helping at or doing the activity that would be authorized by the licence applied for, or a combination of work experience and other qualifications that the Director considers equivalent.

2. In any other case,

   i. successful completion of a course of study, of at least 30 hours, that is approved by the Director for the class of well technician licence described in paragraph 5 of subsection 5 (1), and

   ii. 1,000 hours of work experience helping at or doing the activity that would be authorized by the licence applied for, or a combination of work experience and other qualifications that the Director considers equivalent. O. Reg. 372/07, s. 6 (2).

(3.2) Paragraph 1 of subsection (3.1) applies to an applicant who,

(a) is a member of the Association of Professional Engineers of Ontario as an engineer-in-training;

(b) is a member of the Association of Professional Geoscientists of Ontario as a geoscientist-in-training; or

(c) is a member of the Ontario Association of Certified Engineering Technicians and Technologists as a technician or technologist in training. O. Reg. 372/07, s. 6 (2).

(4) Every holder of a well technician licence shall notify the Director in writing of any change in the information submitted under section 5 or subsection (2) within 10 days after the date of the change. O. Reg. 128/03, s. 7 (2).

7. The following are prescribed as conditions attaching to every well technician licence:

0.1 The licensee shall work or supervise work in connection with the construction of a well only if,

   i. the work is done for a person who holds a well contractor licence, or

   ii. the work is done for a ministry of the Crown and the licensee is employed in the ministry.

1. The licensee shall not supervise the operation of more than two pieces of well construction equipment at one time.

2. The licensee shall work or supervise work in connection with the construction of a well only as specifically authorized by the well technician licence he or she holds.

3. The licensee, while doing or supervising work related to the construction of wells, shall carry a copy of his or her licence and shall produce it upon the request of an employee or agent of the Ministry.

4. The licensee shall comply and shall ensure that every person under his or her supervision shall comply with the requirements of the Act and this Regulation.

5. The licensee shall, promptly after receipt of his or her licence, return to the Director any assistant well technician identification card previously issued to the licensee under this Regulation. R.R.O. 1990, Reg. 903, s. 7; O. Reg. 128/03, s. 8; O. Reg. 372/07, s. 7.

EXAMINATION

8. (1) Every applicant for a well contractor licence or a well technician licence shall take an examination set by the Director. R.R.O. 1990, Reg. 903, s. 8 (1).

(1.1) For the purpose of subsection (1), the Director may set different examinations for different classes of applicants and licences. O. Reg. 372/07, s. 8.

(2) If the applicant for a well contractor licence is a corporation or partnership, the examination required under subsection (1) shall be taken by each of the official representatives referred to in paragraph 1 of section 4. O. Reg. 128/03, s. 9.

(3) An application for an appointment to take an examination shall be on a form supplied by the Ministry and shall be accompanied by the required fee. O. Reg. 128/03, s. 9.

(4) Revoked: O. Reg. 128/03, s. 9.

(5) An applicant who has paid the fee shall be given at least seven days notice of the date, time and place appointed for his or her examination. R.R.O. 1990, Reg. 903, s. 8 (5).

(6) No applicant may try an examination for the same licence more than four times in any period of twelve months. R.R.O. 1990, Reg. 903, s. 8 (6).

(7) For the purposes of subsection (6), an applicant who had an appointment for an examination that he or she did not try shall be deemed to have tried the examination. R.R.O. 1990, Reg. 903, s. 8 (7).

CONTINUING EDUCATION — WELL TECHNICIANS

8.1 (1) If an application is made to renew a well technician licence described in paragraph 1, 2, 3 or 4 of subsection 5 (1), it is a qualification of renewing the licence that the applicant must have successfully completed continuing education courses approved by the Director that consist of a total of at least 21 hours of instruction in the period that ends on the date the application is submitted and began on the later of the following dates:

1. January 1 of the third calendar year preceding the calendar year in which the licence expires.
2. The last day of instruction in a continuing education course that was previously relied on by the applicant for the purpose of this subsection and that ended in the third calendar year preceding the calendar year in which the licence expires. O. Reg. 372/07, s. 9.

(2) If an application is made to renew a well technician licence described in paragraph 5 of subsection 5 (1), it is a qualification of renewing the licence that the applicant must have successfully completed continuing education courses approved by the Director that consist of a total of at least 14 hours of instruction in the period that ends on the date the application is submitted and began on the later of the following dates:

1. January 1 of the third calendar year preceding the calendar year in which the licence expires.
2. The last day of instruction in a continuing education course that was previously relied on by the applicant for the purpose of this subsection and that ended in the third calendar year preceding the calendar year in which the licence expires. O. Reg. 372/07, s. 9.

(3) If a well technician licence is renewed during a calendar year, subsection (1) or (2) does not apply to a further renewal that occurs during the following two calendar years. O. Reg. 372/07, s. 9.

Assistant Well Technician

9. (1) An assistant well technician without an identification card issued under this section is exempt from section 43 of the Act when working at the construction of wells if he or she is supervised by a holder of a well technician licence who is present at the site. O. Reg. 128/03, s. 11.

(2) An assistant well technician to whom an identification card has been issued under this section is exempt from section 43 of the Act when working at the construction of wells on behalf of the licensee named on the card if,

(a) the expiry date on the card has not yet been reached;

(b) he or she carries the card with him or her and produces it on the request of an employee or agent of the Ministry; and

(c) he or she is supervised by the holder of a well technician licence who is available to be called to the site within one hour. O. Reg. 128/03, s. 11.

(3) A holder of a well contractor licence may, not earlier than four months after an assistant well technician begins to work as an employee or agent of the holder of the licence, apply to the Director on a form supplied by the Ministry for an identification card for the technician. O. Reg. 128/03, s. 11.

(4) A holder of a well contractor licence may, when the identification card for the assistant well technician is about to expire, apply to the Director on a form supplied by the Ministry for a new identification card for the technician. O. Reg. 128/03, s. 11.

(5) An identification card issued under this section for an assistant well technician shall bear an expiry date that is not more than 36 months after the date of issue. O. Reg. 128/03, s. 11.

(6) A person for whom an identification card is issued shall return the card to the Director promptly after ceasing to be the employee or agent of the licensed contractor named on the card. O. Reg. 128/03, s. 11.

10. Revoked: O. Reg. 128/03, s. 12.

11., 11.1 Revoked: O. Reg. 372/07, s. 10.

Location of Wells

12. (0.1) Every person constructing a well shall comply with the requirements set out in this section. O. Reg. 372/07, s. 11 (1).

(1) The site of a new well shall be separated,

(a) from an earth pit privy, privy vault, pail privy, greywater system or cesspool, as defined in Ontario Regulation 350/06 (Building Code) made under the *Building Code Act, 1992*, by at least the applicable clearance distance set out in Table 8.2.1.5. of that regulation; and

(b) from a treatment unit, distribution pipe or holding tank, as defined in Ontario Regulation 350/06, by at least the applicable clearance distance set out in Table 8.2.1.6.A., 8.2.1.6.B. or 8.2.1.6.C. of that regulation. O. Reg. 372/07, s. 11 (2).

(1.1) The references in subsection (1) to earth pit privies, privy vaults, pail privies, greywater systems, cesspools, treatment units, distribution pipes and holding tanks include references to earth pit privies, privy vaults, pail privies, greywater systems, cesspools, treatment units, distribution pipes and holding tanks that have not been constructed but for which a building permit has been issued. O. Reg. 372/07, s. 11 (2).

(2) The site of a new drilled well that has a casing that extends to a depth of more than six metres below ground level shall be at least 15 metres from a source of contaminants other than one mentioned in subsection (1). O. Reg. 372/07, s. 11 (3).

(3) The site of,

(a) a new drilled well that does not have a casing that extends to a depth of more than six metres below ground level; or

(b) a new well that is not a drilled well,

shall be at least 30 metres from a source of contaminants other than one mentioned in subsection (1). O. Reg. 128/03, s. 15; O. Reg. 372/07, s. 11 (4, 5).

(4) The site of a new well shall be chosen so that the well is accessible for cleaning, treatment, repair, testing, inspection and visual examination at all times before, during and after completion of construction of the well. O. Reg. 128/03, s. 15.

(5) The site of a new well shall be at an elevation higher than the immediately surrounding area. O. Reg. 128/03, s. 15.

(6) Subsections (1) to (5) do not apply to a test hole or dewatering well. O. Reg. 128/03, s. 15.

(7) A new well shall not be constructed with a well pit, and a well pit shall not be added to an existing well, at any location. O. Reg. 372/07, s. 11 (6).

(7.1) Subsection (7) does not apply in respect of a test hole or dewatering well. O. Reg. 372/07, s. 11 (6).

(8) Despite subsection (7),

(a) a new well may be constructed with a well pit if the well is created by diamond drilling equipment in connection with mineral exploration; and

(b) a well pit may be added to an existing well, if the existing well was created by diamond drilling equipment in connection with mineral exploration. O. Reg. 372/07, s. 11 (7).

(9) If a well pit is permitted pursuant to subsection (7.1) or (8), the following requirements apply to the well pit:

1. Section 13 applies as if the well pit were a well.

2. The floor of the well pit shall be covered with a layer of suitable sealant at least 10 centimetres thick that, when set to a solid state, will be capable of supporting the weight of a person.
3. The top of the well pit shall be covered with a solid, watertight cover, sufficient to prevent the entry of surface water and other foreign materials into the well pit.
4. The cover on the well pit shall be fastened in place in a manner that will make it difficult for children to remove the cover.
5. The well pit shall be kept dry by means of a sump pump.
6. Despite paragraph 5, if the water table is substantially lower than the floor of the well pit, the well pit may be kept dry by means of drainage through a one-way valve that passes through the layer of sealant and that is located near the perimeter of the well pit.
7. The top of the casing of the drilled well shall be at least 40 centimetres above the floor of the well pit.
8. The top of the casing of the drilled well shall be sealed with a commercially manufactured sanitary seal and shall be provided with a length of air vent line sufficient to extend above the covering of the well pit. O. Reg. 128/03, s. 15; O. Reg. 372/07, s. 11 (8, 9).

(10) Paragraphs 4 to 8 of subsection (9) do not apply to a test hole or dewatering well described in subsection 13 (11). O. Reg. 372/07, s. 11 (10).

Log and Field Notes

12.1 (1) Every person constructing or abandoning a well shall make, and have available for inspection at the well site,

(a) a log of overburden and bedrock materials; and

(b) field notes that include an up-to-date record of the construction or abandonment of the well. O. Reg. 372/07, s. 12.

(2) Despite clause (1) (a), a person is not required to have a log of overburden and bedrock materials if,

(a) the person is constructing a well by the use of a driven point;

(b) the person is altering a well without deepening it;

(c) the person is only installing a pump; or

(d) the person is abandoning a well. O. Reg. 372/07, s. 12.

Covering of Well

12.2 Whenever a well under construction is left unattended, including during a minor alteration or the installation of a pump, the person constructing the well shall cover the upper open end of the well securely in a manner sufficient to prevent entry into it of surface water and other foreign materials. O. Reg. 372/07, s. 12.

Surface Drainage

12.3 The person constructing the well shall ensure that the surface drainage is such that water will not collect or pond in the vicinity of the well. O. Reg. 372/07, s. 12.

Well Depth

12.4 (1) If a new well is constructed by any method, the person constructing the well shall ensure that the well is at least six metres deep, unless the only useful aquifer available necessitates a shallower well, in which case the person constructing the well shall ensure that the well is at least three metres deep. O. Reg. 372/07, s. 12.

(2) Subsection (1) does not apply to a test hole or dewatering well. O. Reg. 372/07, s. 12.

Casing and Well Screen

13. (0.1) Every person constructing a new well shall comply with the requirements set out in this section. O. Reg. 372/07, s. 13 (1).

(1) Casing and well screen shall be new material. O. Reg. 128/03, s. 16; O. Reg. 372/07, s. 13 (2).

(2) Subsection (1) does not apply to a test hole or dewatering well if abandonment of the test hole or dewatering well is scheduled to take place not later than 180 days after completion of the structural stage of the test hole or dewatering well. O. Reg. 128/03, s. 16; O. Reg. 372/07, s. 13 (3).

(3) Casing and well screen shall be clean and free of contamination. O. Reg. 128/03, s. 16; O. Reg. 372/07, s. 13 (4).

(4) Casing and well screen shall not impair the quality of water with which it comes in contact. O. Reg. 128/03, s. 16; O. Reg. 372/07, s. 13 (5).

(5) Casing shall be watertight. O. Reg. 128/03, s. 16.

(6) Any seams in casing shall achieve a permanent watertight bond. O. Reg. 128/03, s. 16.

(7) If concrete casing is used,

(a) the concrete casing sections shall be fully cured and commercially manufactured;

(b) the concrete casing sections shall be properly aligned in the well so that the joints are flush and the casing is centred; and

(c) the concrete casing sections shall be joined with a mastic sealing material that remains pliable and waterproof and that is approved for potable water use by NSF International. O. Reg. 372/07, s. 13 (6).

(8) A well that obtains water from overburden shall be cased from the water intake zone to at least 40 centimetres above the highest point on the ground surface within three metres radially from the outside of the casing, after the surface drainage conforms with section 12.3, as measured on completion of the well's structural stage. O. Reg. 372/07, s. 13 (6).

(9) A well that obtains water from bedrock shall be cased from the bedrock to at least 40 centimetres above the highest point on the ground surface within three metres radially from the

outside of the casing, after the surface drainage conforms with section 12.3, as measured on completion of the well's structural stage. O. Reg. 372/07, s. 13 (6).

(10) Subsections (8) and (9) do not require a cased well to be cased to the height set out in those subsections if,

(a) the well is made by the use of a jetted point or driven point;

(b) the well is cased, from the highest point on the ground surface within three metres radially from the outside of the casing, after the surface drainage conforms with section 12.3, to,

(i) the water-producing zone, if the well obtains water from overburden, or

(ii) the bedrock, if the well obtains water from bedrock;

(c) the top of the casing is above ground at a height sufficient to permit attachment of the well tag; and

(d) a permanent marker identifies the location of the well and is visible at all times of the year. O. Reg. 372/07, s. 13 (6).

(11) Subsections (8) and (9) do not require a cased test hole or cased dewatering well to be cased above the ground surface if,

(a) the well is located where vehicle or pedestrian traffic is likely to pass directly over the well;

(b) the well is completed with a flush-mounted watertight commercially manufactured well cover sufficient to prevent entry of surface water and other foreign materials into the well; and

(c) the well cover is sufficiently strong, durable and well-installed to protect the well from damage, or the well cover is covered with a metal plate that is sufficiently large and sufficiently strong, durable and well-installed to protect the well cover and the well from damage. O. Reg. 372/07, s. 13 (6).

(11.1) A test hole or dewatering well is not required to be cased if,

(a) abandonment of the test hole or dewatering well is scheduled to take place not later than 30 days after completion of the structural stage of the test hole or dewatering well; and

(b) the person constructing the well covers the upper open end of the well securely in a manner sufficient to prevent the entry of surface water and other foreign materials whenever the well is left unattended. O. Reg. 372/07, s. 13 (6).

(11.2) A well that is required to be cased shall, despite subsections (8), (9) and (10),

(a) have at least six metres of casing below the level of the original ground surface, unless clause (b) applies; or

(b) have at least 2.5 metres of casing below the level of the original ground surface, if a casing that extended to six metres below the level of the original ground surface would not permit the use of the only useful aquifer. O. Reg. 372/07, s. 13 (6).

(11.3) Subsection (11.2) does not apply to at test hole or dewatering well. O. Reg. 372/07, s. 13 (6).

(12) The casing of a drilled well that obtains water from bedrock, other than from the weathered bedrock zone, shall be sealed into the bedrock with suitable sealant to prevent impairment of the quality of the ground water and the water in the well. O. Reg. 372/07, s. 13 (7).

(13) Subsection (12) does not apply to a test hole or dewatering well. O. Reg. 128/03, s. 16.

(14) If a well is constructed with a well pit pursuant to subsection 12 (8),

(a) subsections (8) and (9) do not require the well to be cased above the ground surface; and

(b) the well pit shall be cased from the bottom of the well pit to at least 40 centimetres above the highest point on the ground surface within three metres radially from the outside of the well pit casing, after the surface drainage conforms with section 12.3, as measured at the time the well pit is completed. O. Reg. 372/07, s. 13 (8).

(15) Revoked: O. Reg. 372/07, s. 13 (8).

(16) The following are the minimum specifications for casing:

1. In the case of high yield wells, the casing specifications in Table 2 of AWWA A100-06, as it may be amended from time to time.
2. The outer permanent casing in double walled casing constructions must be steel pipe that conforms to ASTM A252 or ASTM A500.
3. Steel casing with an inside diameter of more than 50.8 millimetres must have a nominal wall thickness of 4.78 millimetres and a minimum wall thickness of 4.18 millimetres and must conform to ASTM A-53 Grade B, ASTM A589 Grade B or ASTM A500 Grade B or C.
4. Steel casing with an inside diameter of 50.8 millimetres or less must have a nominal wall thickness of 2.77 millimetres and a minimum wall thickness of 2.41 millimetres and must conform to ASTM A-53 Grade B, ASTM A589 Grade B or ASTM A500 Grade B or C.
5. Galvanized steel casing that is corrugated and that is used in bored or dug wells must be 18 gauge and must conform to ASTM A-53 Grade B, ASTM A589 Grade B or ASTM A500 Grade B or C.
6. Concrete casing with an inside diameter of 60.96 centimetres or more must have nominal wall thickness of 5.08 centimetres.
7. Plastic casing with an inside diameter of 10.16 centimetres or more must have a minimum wall thickness of 0.635 centimetres and must be ABS or PVC pipe approved for potable water use by the Canadian Standards Association, the Canadian Society for Testing and Materials, ASTM or NSF International.
8. Fibre-reinforced plastic casing must be manufactured from virgin resin and virgin fibres and must be approved for potable water use by NSF International. O. Reg. 128/03, s. 16; O. Reg. 372/07, s. 13 (9, 10).

(17) Subsection (16) does not apply to a test hole or dewatering well. O. Reg. 128/03, s. 16; O. Reg. 372/07, s. 13 (11).

(18) The casing used in a well shall be continuous casing. O. Reg. 128/03, s. 16.

(19) Joints in casing are prohibited, except for joints that,

(a) achieve a permanent, watertight bond, such as welded steel joints; and

(b) are made so that the jointed casing does not impair the quality of water with which it comes in contact. O. Reg. 128/03, s. 16.

(20) The annular space between casings of different diameters shall be sealed with suitable sealant to prevent the entry into the well of surface water and other foreign materials. O. Reg. 128/03, s. 16; O. Reg. 372/07, s. 13 (12).

(21) No person shall ground a lightning rod by attaching it, directly or indirectly, to the casing of a well. O. Reg. 128/03, s. 16.

DEEPENING OF WELLS

13.1 (1) If a well is deepened, section 13 applies, with necessary modifications, as if a new well were being constructed, but continued use of the casing in the existing well is permitted if the casing appears sound. O. Reg. 372/07, s. 14.

(2) No person shall construct a well by penetrating through the bottom of a bored or dug well by means of drilling or by the use of a jetted point or driven point. O. Reg. 372/07, s. 14.

ANNULAR SPACE — SUBSURFACE MOVEMENT

14. If a new well is constructed by any method, the person constructing the well shall ensure that any annular space, other than annular space surrounding a well screen, is sealed to prevent any movement of water, natural gas, contaminants or other material between subsurface formations or between a subsurface formation and the ground surface by means of the annular space. O. Reg. 372/07, s. 15.

ANNULAR SPACE — CONSTRUCTION AND SEALING OF DRIVEN POINT WELLS

14.1 (1) If a new well is constructed by the use of a driven point, the person constructing the well shall comply with section 14 by ensuring that any annular space is filled to the ground surface using a material and a method approved in writing by the Director that, in the opinion of the Director, will ensure that there are no gaps or air spaces in the material placed in the annular space. O. Reg. 372/07, s. 15.

(2) Subsection (1) does not apply to a test hole or dewatering well if abandonment of the test hole or dewatering well is scheduled to take place not later than 180 days after completion of the structural stage of the test hole or dewatering well. O. Reg. 372/07, s. 15.

ANNULAR SPACE — CONSTRUCTION AND SEALING OF BORED WELLS WITH CONCRETE CASING

14.2 (1) If a new well is constructed by boring and concrete casing is used, the person constructing the well shall ensure that the well is constructed with a diameter that,

(a) from the ground surface to a depth of 2.5 metres, is at least 15.2 centimetres greater than the outside diameter of the casing that will be used; and

(b) from a depth of 2.5 metres to a depth of at least the full depth of the well or six metres, whichever is less, is at least 7.6 centimetres greater than the outside diameter of the casing that will be used. O. Reg. 372/07, s. 15.

(2) If a new well is constructed by boring and concrete casing is used in the well, the person constructing the well shall comply with section 14 by ensuring that the following rules are complied with:

1. If a well screen is installed,

    i. the annular space shall be filled, from the bottom of the well to at least the top of the well screen with clean, washed gravel or sand that is deposited after placement of the well screen and casing, and

    ii. any remaining annular space shall be filled with suitable sealant, upward from the top of the gravel or sand referred to in subparagraph i to the bottom of the bentonite material referred to in paragraph 6.

2. The top of the gravel or sand referred to in subparagraph 1 i shall not be closer than six metres to the ground surface, unless the only useful aquifer available necessitates a shallower well, in which case the top of the gravel or sand shall not be closer than 2.5 metres to the ground surface.

3. If no well screen is installed, the annular space shall be filled with suitable sealant from the bottom of the casing upward to the bottom of the bentonite material referred to in paragraph 6.

4. The sealant referred to in subparagraph 1 ii or paragraph 3 shall be continuously deposited by forcing sealant through a tremie pipe, with the bottom end of the pipe immersed in the rising accumulation of sealant.

5. If the sealant referred to in subparagraph 1 ii or paragraph 3 contains cement,

    i. it shall be allowed to set according to the manufacturer’s specifications or for 12 hours, whichever is longer, and

    ii. if, after setting in accordance with subparagraph i, the sealant has settled or subsided, it shall be topped up to the original level.

6. From the ground surface to a depth of at least 2.5 metres, the annular space shall be filled with bentonite granules, pellets or chips that have been screened in accordance with the manufacturer’s specifications and that have a diameter of not more than 20 millimetres and not less than six millimetres. O. Reg. 372/07, s. 15.

(3) Subsections (1) and (2) do not apply to a test hole or dewatering well if abandonment of the test hole or dewatering well is scheduled to take place not later than 180 days after completion of the structural stage of the test hole or dewatering well. O. Reg. 372/07, s. 15.

Annular Space — Construction and Sealing of Dug Wells

14.3 (1) If a new well is constructed by digging, the person constructing the well shall comply with section 14 by ensuring that the annular space is filled to the ground surface in accordance with the following rules:

1. The annular space from the bottom of the well to a depth not closer to the ground surface than 2.5 metres shall be filled with,

    i. clean, washed gravel or sand, or

    ii. native materials that were excavated from the hole, if the well is not constructed in a contaminated area and the major horizons of soil are excavated separately, stored separately, kept free from contamination and backfilled in the same relative positions that they originally occupied.

2. The remainder of the annular space shall be filled with suitable sealant that will provide the appropriate structural strength to support the weight of persons and vehicles that may move over the area after it is filled. O. Reg. 372/07, s. 15.

(2) Subsection (1) does not apply to a test hole or dewatering well if abandonment of the test hole or dewatering well is scheduled to take place not later than 180 days after completion of the structural stage of the test hole or dewatering well. O. Reg. 372/07, s. 15.

Annular Space — Construction and Sealing of Drilled and Other Wells

14.4 (1) If a new well is constructed by any method, other than a method described in section 14.1, 14.2 or 14.3 or by the use of a jetted point, the person constructing the well shall ensure that the well is constructed with a diameter that, from the ground surface to a depth of at least the full depth of the well or six metres, whichever is less, is at least 7.6 centimetres greater than the outside diameter of the casing that will be used. O. Reg. 372/07, s. 15.

(2) If a new well is constructed by any method, other than a method described in section 14.1, 14.2 or 14.3 or by the use of a jetted point, the person constructing the well shall comply with section 14 by ensuring that the following rules are complied with:

1. If a well screen is installed,

    i. the annular space shall be filled, from the bottom of the well to at least the top of the well screen with clean, washed gravel or sand that is,

        A. deposited during or after placement of the well screen and casing, or

        B. developed, after placement of the sealant referred to in subparagraph ii, by surging water through the well screen to remove the adjacent fine grained soils, and

    ii. any remaining annular space shall be filled with suitable sealant, upward from the top of the gravel or sand referred to in subparagraph i to the ground surface.

2. If no well screen is installed, the annular space shall be filled with suitable sealant from the bottom of the casing upward to the ground surface.

3. The top of the gravel or sand referred to in paragraph 1 shall not be closer than six metres to the ground surface, unless the only useful aquifer available necessitates a shallower well, in which case the top of the gravel or sand shall not be closer than 2.5 metres to the ground surface.
4. The sealant referred to in paragraphs 1 and 2 shall be continuously deposited by forcing sealant through a tremie pipe, with the bottom end of the pipe immersed in the rising accumulation of sealant.
5. If the sealant referred to in paragraphs 1 and 2 contains cement,
   i. it shall be allowed to set according to the manufacturer's specifications or for 12 hours, whichever is longer, and
   ii. if, after setting in accordance with subparagraph i, the sealant has settled or subsided, it shall be topped up to the original level. O. Reg. 372/07, s. 15.

(3) Subsection (1) does not apply to a well if,

(a) the well is constructed with a diameter that, from the ground surface to a depth of at least the full depth of the well or six metres, whichever is less, is at least 5.1 centimetres greater than the outside diameter of the casing that will be used;

(b) the suitable sealant used to comply with subsection (2) has a maximum particle size that will not be subject to bridging; and

(c) proper alignment is ensured by,

(i) in the case of a well constructed using a cable tool rig, the use of a breakaway guide for centering the casing that does not impair the quality of the water with which it comes into contact and that is placed two metres above the bottom of the casing, or

(ii) in the case of a well constructed using a rotary rig, the use of centralizers located below a depth of six metres. O. Reg. 372/07, s. 15.

(4) Subsections (1) to (3) do not apply to a test hole or dewatering well if abandonment of the test hole or dewatering well is scheduled to take place not later than 180 days after completion of the structural stage of the test hole or dewatering well. O. Reg. 372/07, s. 15.

Annular Space — Wells with a Well Pit

14.5 (1) If a new well is constructed by any method and the well is constructed with a well pit,

(a) the person constructing the well shall ensure that the well pit is constructed with a diameter that, from the bottom of the well pit to the ground surface, is at least 7.6 centimetres greater than the outside diameter of the well pit; and

(b) the person constructing the well shall ensure that the annular space outside the well casing is filled, from the bottom of the well pit to the ground surface, with suitable sealant that will provide the appropriate structural strength to support the weight of persons and vehicles that may move over the area after it is filled. O. Reg. 372/07, s. 15.

(2) If the sealant referred to in clause (1) (b) contains cement,

(a) it shall be allowed to set according to the manufacturer's specifications or for 12 hours, whichever is longer; and

(b) if, after setting in accordance with clause (a), the sealant has settled or subsided, it shall be topped up to the original level. O. Reg. 372/07, s. 15.

(3) Subsections (1) and (2) do not apply to a test hole or dewatering well if abandonment of the test hole or dewatering well is scheduled to take place not later than 180 days after completion of the structural stage of the test hole or dewatering well. O. Reg. 372/07, s. 15.

ANNULAR SPACE — WELLS WITH DOUBLE WALLED CASING

14.6 Sections 14 to 14.5 do not apply to a well that is constructed with a casing surrounded by a permanent casing of larger diameter (sometimes referred to as a double walled casing), but,

(a) sections 14, 14.2, 14.3, 14.4 and 14.5 apply, with necessary modifications, to the annular space outside the outer casing; and

(b) sections 14.2, 14.3 and 14.4 apply, with necessary modifications, to the annular space between the casings, unless there is no ground water leaking into the annular space between the casings. O. Reg. 372/07, s. 15.

FLOWING WELLS

14.7 (1) If, during construction of a well, the well becomes a flowing well, the person constructing the well,

(a) shall construct the well to accommodate and be compatible with an appropriate device that controls the discharge of water from within the well casing, is capable of stopping the discharge of water from within the well casing, and is capable of withstanding the freezing of water in the well casing;

(b) shall install a device described in clause (a);

(c) shall construct the well and install the device described in clause (a) in a manner that prevents any uncontrolled flow of water from the well or at the well site; and

(d) shall construct the well and install the device described in clause (a) in a manner that prevents backflow of water into the well or well casing. O. Reg. 372/07, s. 15.

(2) Subsection (1) does not apply if the well is abandoned in accordance with section 21.1. O. Reg. 372/07, s. 15.

(3) Every contract for the construction of a well shall be deemed to contain a term that makes the well contractor responsible for,

(a) the cost of complying with subsection (1); and

(b) if subsection (1) does not apply pursuant to subsection (2), the cost of abandoning the well. O. Reg. 372/07, s. 15.

(4) Subsection (3) does not apply to a written contract that expressly releases the well contractor from the responsibility referred to in that subsection. O. Reg. 372/07, s. 15.

Development

14.8 (1) Before the structural stage of a new well is completed, the person constructing the well shall do everything reasonably practicable to remove any debris, including well cuttings and drilling fluids, from the well by developing the well until the well water is clear and free of sand. O. Reg. 372/07, s. 15.

(2) Subsection (1) does not apply to a test hole or a dewatering hole. O. Reg. 372/07, s. 15.

Well Yield

14.9 (1) Before the structural stage of a well is completed, the person constructing the well shall test the yield of the well in accordance with section 14.10. O. Reg. 372/07, s. 15.

(2) Subsection (1) does not apply to a minor alteration of a well or the installation of a pump. O. Reg. 372/07, s. 15.

(3) Subsection (1) does not apply to a test hole or dewatering well if the person constructing it,

(a) measures the static water level in the well by means of a plastic or metal tape, an air line or an electrical device; and

(b) ensures that any part of the tape, air line or electrical device that comes into contact with water in the well is clean. O. Reg. 372/07, s. 15.

(4) Subsection (1) does not apply to an alteration of a well that involves only,

(a) the removal of the casing above the ground surface so that the casing is flush with the ground surface;

(b) the addition of casing above the ground surface; or

(c) the creation or removal of a well pit. O. Reg. 372/07, s. 15.

14.10 (1) If the yield of water from a well is tested,

(a) the water level in the well shall be measured and recorded on the well record for the well,

(i) immediately before commencement of pumping,

(ii) at one minute intervals or more frequently during the first five minutes of pumping,

(iii) at five minute intervals or more frequently during the next 25 minutes of pumping,

(iv) at 10 minute intervals or more frequently during the next 30 minutes of pumping,

(v) at one minute intervals or more frequently during the first five minutes after pumping stops,

(vi) at five minute intervals or more frequently during the next 25 minutes after pumping stops, and

(vii) at 10 minute intervals or more frequently during the next 30 minutes after pumping stops;

(b) the water level in the well shall be measured by means of a plastic or metal tape that is clean or an air line or electrical device that is clean;

(c) water shall be pumped from the well at a steady rate, continuously for at least one hour; and

(d) the rate of pumping during the test shall be recorded on the well record. O. Reg. 372/07, s. 15.

(2) Clauses (1) (a) and (b) do not apply if the design of the well does not allow for the water level in the well to be measured during the test of water yield from the well. O. Reg. 372/07, s. 15.

(3) If water cannot be pumped from the well continuously for one hour in accordance with clause (1) (c), no further measurements are required under clause (1) (a) and there shall be recorded on the well record,

(a) the reason pumping was discontinued;

(b) the rate of pumping and the length of the pumping period; and

(c) the water level measurements made. O. Reg. 372/07, s. 15.

WELL TAG

14.11 (1) Before the structural stage of a new cased well is completed, the person constructing the well shall obtain a well tag from the Ministry and shall affix it permanently to the outside of the casing or to a permanent structure associated with the well, at a point where the well tag will be visible and will not be obstructed by the well cap, by other components of the well or by equipment associated with the well. O. Reg. 372/07, s. 15.

(2) If an alteration, other than a minor alteration, is made to a cased well that does not already have a well tag, the person making the alteration shall obtain a well tag from the Ministry and, before the alteration is completed, shall affix the well tag permanently to the outside of the casing or to a permanent structure associated with the well, at a point where the well tag will be visible and will not be obstructed by the well cap, by other components of the well or by equipment associated with the well. O. Reg. 372/07, s. 15.

(3) If an alteration is made to a cased well that already has a well tag, the person making the alteration shall safeguard the well tag during the alteration and, if the well tag is removed, the person making the alteration shall, before the alteration is completed, reaffix the well tag permanently to the outside of the casing or to a permanent structure associated with the well, at a point where the well tag will be visible and will not be obstructed by the well cap, by other components of the well or by equipment associated with the well. O. Reg. 372/07, s. 15.

(4) Despite subsection (3), if an alteration is made to a cased well that already has a well tag and the well tag is broken, defaced, illegible or otherwise unusable, the person making the alteration shall,

(a) remove the well tag and return it, not later than the date clause (c) is complied with, to the Director;

(b) obtain a new well tag from the Ministry and, before the alteration is completed, affix the well tag permanently to the outside of the casing or to a permanent structure associated with the well, at a point where the well tag will be visible and will not be obstructed by the well cap, by other components of the well or by equipment associated with the well; and

(c) within 30 days after the new well tag is affixed to the casing, complete a well record with respect to the replacement of the well tag and forward a copy of the well record to the Director. O. Reg. 372/07, s. 15.

(5) Despite subsections (1) to (4), if one well record is prepared for a cluster of wells in accordance with section 16.4 and a well tag is affixed to the deepest well in the cluster, it is not necessary to affix a well tag to any other well in the cluster. O. Reg. 372/07, s. 15.

DISINFECTION

15. (1) On the day the structural stage of the well is completed, the person constructing the well shall ensure that,

(a) any remaining debris is removed from the well;

(b) the water in the well is dosed to a concentration of not less than 50 milligrams per litre and not more than 200 milligrams per litre of free chlorine and left undisturbed for a period of at least 12 hours; and

(c) the water in the well is not used for human consumption until the steps required by subsections (2) to (7) are taken. O. Reg. 372/07, s. 16.

(2) A person who undertakes construction of a well that is being used or maintained for use for the purpose for which it was constructed or installs pumping equipment in a well shall ensure that as soon as possible after the construction or installation is complete, the water in the well is dosed to a concentration of not less than 50 milligrams per litre and not more than 200 milligrams per litre of free chlorine. O. Reg. 372/07, s. 16.

(3) Subsection (2) does not apply to the replacement of a pump that is installed above or adjacent to a well or in a well pit unless the replacement involves the removal of a well cover or well cap required by subsection 15.2 (6) or (7). O. Reg. 372/07, s. 16.

(4) A person referred to in subsection (2) shall ensure that, at least 12 hours and not more than 24 hours after the water is chlorinated, the well water is tested for free chlorine residual. O. Reg. 372/07, s. 16.

(5) If, according to a test under subsection (4), the concentration of free chlorine residual in the well water is less than 50 milligrams per litre or more than 200 milligrams per litre, the person referred to in subsection (2) shall ensure that the following steps are taken:

1. Water shall be pumped out of the well until the concentration of free chlorine residual in the well water is less than 1 milligram per litre.
2. The water in the well shall be dosed to a concentration of not more than 200 milligrams per litre of free chlorine.
3. At least 12 hours and not more than 24 hours after the water is dosed under paragraph 2, the well water shall be tested for free chlorine residual.
4. If, according to a test under paragraph 3, the concentration of free chlorine residual in the well water is less than 50 milligrams per litre or more than 200 milligrams per litre, the

steps referred to in paragraphs 1 to 3 and this paragraph shall be repeated. O. Reg. 372/07, s. 16.

(6) A person who is required to ensure that steps set out in subsection (5) are taken shall ensure that,

(a) subject to paragraph 4 of subsection (5), the steps are taken in the sequence in which they are set out in subsection (5); and

(b) each step is taken as soon as reasonably possible. O. Reg. 372/07, s. 16.

(7) If, according to a test under subsection (4) or paragraph 3 of subsection (5), the concentration of free chlorine residual in the well water is 50 milligrams per litre or more but not more than 200 milligrams per litre, the person who is referred to in subsection (2) shall ensure that water is pumped out of the well until the concentration of free chlorine residual in the well water is less than 1 milligram per litre. O. Reg. 372/07, s. 16.

(8) No person shall, during a period between the chlorination of the water in a well by a person referred to subsection (2) and the testing of the well water for free chlorine residual under this section,

(a) disturb the well; or

(b) use the well for any purpose. O. Reg. 372/07, s. 16.

(9) A person who is responsible for ensuring that well water is tested for free chlorine residual under this section shall ensure that, before the well is used as a source of water for human consumption, the well purchaser is given a written record of the test results. O. Reg. 372/07, s. 16.

(10) Subsections (4) to (9) do not apply to an alteration of a well if all of the following criteria are satisfied:

1. The alteration involves the urgent replacement or repair of a pump that unexpectedly failed.
2. No water supply is immediately available as an alternative to the water from the well.
3. The well purchaser provides the person who undertakes the alteration with written instructions to discontinue the disinfection process after complying with subsection (2). O. Reg. 372/07, s. 16.

(11) If, pursuant to subsection (10), subsections (4) to (9) do not apply to an alteration of a well,

(a) the well purchaser shall ensure that, before the well water is used for any purpose, water is pumped from the well until no odour of chlorine remains in the well water; and

(b) the person who undertakes the alteration shall retain the written instructions referred to in paragraph 3 of subsection (10) for two years. O. Reg. 372/07, s. 16.

(12) This section does not apply if the Director gives written approval to another method of disinfection and the approved method is complied with. O. Reg. 372/07, s. 16.

(13) This section does not apply to a minor alteration of a well. O. Reg. 372/07, s. 16.

(14) This section does not apply to a test hole, dewatering well or flowing well. O. Reg. 372/07, s. 16.

Venting

15.1 (1) If a new well is constructed by any method, the person constructing the well shall ensure that the well is vented to the outside atmosphere in a manner that will safely disperse all gases. O. Reg. 372/07, s. 16.

(2) Subsection (1) does not apply to,

(a) a test hole; or

(b) a well in which casing is used to transmit water out of the well. O. Reg. 372/07, s. 16.

(3) If a pump is installed in a drilled well, the person constructing the well shall ensure that,

(a) an air vent is installed with a minimum inside diameter of,

(i) 0.3 centimetres, if the inside diameter of the casing is less than 12.7 centimetres, or

(ii) 1.2 centimetres, if the inside diameter of the casing is 12.7 centimetres or more;

(b) the air vent,

(i) is of sufficient length to extend above the covering of the well pit, if a well pit exists, or

(ii) extends above the ground surface a distance sufficient to prevent the entry of flood water from any anticipated flooding in the area but not less than 40 centimetres, if no well pit exists; and

(c) the open end of the air vent is shielded and screened in a manner sufficient to prevent the entry of any materials into the well. O. Reg. 372/07, s. 16.

(4) Subsection (3) does not apply to an uncased test hole or an uncased dewatering well. O. Reg. 372/07, s. 16.

(5) Subsection (3) does not apply to the following wells if there is no potential hazard from natural gas or any other gas:

1. A well with a well pit.
2. A test hole or dewatering well described in subsection 13 (11). O. Reg. 372/07, s. 16.

Installation of Equipment

15.2 (1) Every person constructing a well shall comply with the requirements set out in this section. O. Reg. 372/07, s. 16.

(2) If a connection to the casing of a drilled well is made below the ground surface, a well seal or pitless adapter shall be used and the connection shall be made watertight. O. Reg. 372/07, s. 16.

(3) A cutting torch shall not be used to make an opening in the casing wall to accommodate a pitless adapter. O. Reg. 372/07, s. 16.

(4) If a connection to the casing of a well, other than a drilled well, is made below the ground surface, the connection shall be made watertight with durable bonding material. O. Reg. 372/07, s. 16.

(5) If a connection to the casing of a well is made below the ground surface, any outside excavation shall be filled with suitable sealant extending from the casing a minimum distance outward of 20 centimetres and extending from the bottom of the excavation to within 20 centimetres of the ground surface. O. Reg. 372/07, s. 16.

(6) The top of the casing of a well that is constructed by digging or boring shall be covered with a solid, watertight well cover, sufficient to prevent the entry of surface water and other foreign materials into the well. O. Reg. 372/07, s. 16.

(7) Subject to paragraph 8 of subsection 12 (9), the top of the casing of a well that is not constructed by digging or boring shall be sealed with a commercially manufactured vermin-proof well cap. O. Reg. 372/07, s. 16.

(8) Subsections (6) and (7) do not apply if all of the following criteria are satisfied:

1. A floor has been constructed around or adjacent to the casing of the well.
2. A pump is installed above or adjacent to the well.
3. The top of the casing is shielded in a manner sufficient to prevent entry of any material that may impair the quality of the water in the well.
4. The casing of the well is extended to at least 15 centimetres above the floor referred to in paragraph 1. O. Reg. 372/07, s. 16.

15.3 A person who installs equipment in a well shall ensure that the equipment is clean. O. Reg. 372/07, s. 16.

INFORMATION

16. (1) Where a well is constructed and mineralized water is encountered, the person constructing the well shall immediately notify the well purchaser and the owner of the land on which the well is situated that the condition exists. O. Reg. 372/07, s. 17.

(2) Subsection (1) does not apply to a test hole or dewatering well. O. Reg. 372/07, s. 17.

(3) Where a well is constructed and natural gas is encountered, the person constructing the well shall immediately notify the well purchaser, the owner of the land on which the well is situated and the Director that the condition exists. O. Reg. 372/07, s. 17.

16.1 (1) On the day the structural stage of a well is completed, the person constructing the well shall, unless the well purchaser otherwise directs,

(a) deliver to the well purchaser a copy of an information package about wells obtained from the Ministry;

(b) provide the well purchaser with a water sample from the well of at least one litre for visual examination; and

(c) measure the depth of the well in the presence of the well purchaser. O. Reg. 372/07, s. 17.

(2) Subsection (1) does not apply to a test hole or dewatering well. O. Reg. 372/07, s. 17.

(3) Subsection (1) does not apply to a minor alteration of a well. O. Reg. 372/07, s. 17.

16.2 (1) On the day a pump is replaced in an existing well, the person constructing the well shall, unless the well purchaser otherwise directs, deliver to the well purchaser a copy of an information package about wells obtained from the Ministry. O. Reg. 372/07, s. 17.

(2) Subsection (1) does not apply to a test hole or dewatering well. O. Reg. 372/07, s. 17.

RECORDS — SINGLE WELL RECORD

16.3 (1) On completion of a well's structural stage, the person constructing the well shall,

(a) complete, in accordance with the instructions on the form, a well record for the well;

(b) deliver a copy of the well record to the well purchaser and the owner of the land on which the well is situated within 14 days after the date on which the well's structural stage is complete;

(c) forward a copy of the well record to the Director within 30 days after the date on which the well's structural stage is complete; and

(d) retain a copy of the well record for two years. O. Reg. 372/07, s. 17.

(2) Subsection (1) does not apply to a minor alteration of a well or the installation of a pump. O. Reg. 372/07, s. 17.

(3) Subsection (1) does not apply in respect of a test hole or dewatering well that is abandoned within 30 days after the date on which its structural stage is complete. O. Reg. 372/07, s. 17.

RECORDS — WELL CLUSTERS

16.4 (1) Despite clause 16.3 (1) (a), a person constructing wells may complete one well record for a group of wells instead of a separate well record for each individual well if all the following circumstances exist:

1. Every well in the group is a test hole or dewatering well.
2. Every well in the group is located,
   - i. on the same property as another well in the group,
   - ii. on a property that is adjacent to a property on which another well in the group is located, or that would be adjacent but for a road between the two properties, or
   - iii. on a property that has only one or two intervening properties between it and a property on which another well in the group is located.
3. The structural stage of every well in the group is complete or, if the wells are being constructed in phases, the structural stage of every well in the relevant phase of construction is complete.
4. Each owner of land on which a well in the group is situated has given written consent to the use of a single well record for the group and the well record states that all the required consents have been given. O. Reg. 372/07, s. 17.

(2) For the purpose of subparagraph 2 iii of subsection (1), the following rules apply to the determination of the number of intervening properties between two properties on which wells are located:

1. The number of intervening properties shall be determined along a straight line joining the two wells.
2. If the straight line mentioned in paragraph 1 crosses a road, the road shall not be counted as an intervening property, unless one or both of the two wells is located on or inside the boundaries of the road.
3. If part of the straight line mentioned in paragraph 1 is on or within the boundaries of a road, the number of intervening properties shall be determined with reference to the properties adjacent to that portion of the road, on the side of the road that has fewer properties. O. Reg. 372/07, s. 17.

(3) A person constructing wells who completes one well record for a well cluster under subsection (1) shall,

(a) indicate in the well record, in a convenient, concise and comprehensive manner, which of the wells share common features, such as diameter, construction technique, casing, venting, pumps and method of abandonment;

(b) include in the well record a statement that the person constructing the well will promptly submit to the Director, on request, any additional information in the person’s custody or control related to any well in the well cluster that the person has constructed;

(c) despite clause 16.3 (1) (b), deliver to the well purchaser and each owner of land on which a well in the well cluster is situated a copy of the well record for the well cluster within 60 days after the commencement of construction of the first well or, if the wells are being constructed in phases, within 60 days after the commencement of construction of the first well in the relevant phase of construction; and

(d) despite clause 16.3 (1) (c), forward a copy of the well record for the well cluster to the Director within 75 days after the commencement of construction of the first well or, if the wells are being constructed in phases, within 75 days after the commencement of construction of the first well in the relevant phase of construction. O. Reg. 372/07, s. 17.

(4) If one well record is completed for a well cluster under subsection (1) and an alteration, other than a minor alteration, is made to a well in the well cluster,

(a) this section ceases to apply to that well; and

(b) the person making the alteration shall obtain and affix a well tag in accordance with subsection 14.11 (2) and comply with section 16.3. O. Reg. 372/07, s. 17.

(5) A person constructing a well who completes a new well record under subsection (4) shall,

(a) despite clause 16.3 (1) (b), deliver to the well purchaser and each owner of the land on which the well in the well cluster is affected by the subsequent construction a copy of the well record within 60 days after the commencement of the subsequent construction or, if

the subsequent construction is done in phases, within 60 days after the commencement of the relevant phase of the subsequent construction; and

(b) despite clause 16.3 (1) (c), forward a copy of the well record to the Director within 75 days after the commencement of the subsequent construction or, if the subsequent construction is done in phases, within 75 days after the commencement of the relevant phase of the subsequent construction. O. Reg. 372/07, s. 17.

RECORDS — WELL ABANDONMENT

16.5 (1) On completion of the abandonment of a well, the person abandoning the well shall,

(a) complete, in accordance with the instructions on the form, a well record for the well;

(b) deliver a copy of the well record to the owner of the land on which the well is situated,

(i) within 14 days after the date on which the well construction equipment is removed from the site, or

(ii) in the case of a well cluster, within 60 days after the date on which the first well in the well cluster is abandoned; and

(c) forward a copy of the well record, and any well tag that was removed from the well, to the Director,

(i) within 30 days after the date on which the well construction equipment is removed from the site, or

(ii) in the case of a well cluster, within 75 days after the date on which the first well in the well cluster is abandoned. O. Reg. 372/07, s. 17.

(2) Subsection (1) does not apply in respect of a test hole or dewatering well that is abandoned within 30 days after the date on which its structural stage is complete. O. Reg. 372/07, s. 17.

17.-19. Revoked: O. Reg. 372/07, s. 18.

WELL MAINTENANCE

20. (1) The well owner shall maintain the well at all times after the completion of the well's structural stage in a manner sufficient to prevent the entry into the well of surface water and other foreign materials. O. Reg. 372/07, s. 19.

(2) If the casing of a well extends above the ground surface, no person shall,

(a) reduce the height of the casing, if the casing of the well extends to a height of less than 40 centimetres above the ground surface; or

(b) reduce the height of the casing to a height of less than 40 centimetres above the ground surface, if the casing extends to a height of 40 centimetres or more above the ground surface. O. Reg. 372/07, s. 19.

(3) Subsection (2) does not apply to a well described in subsection 13 (10) or a test hole or dewatering well described in subsection 13 (11). O. Reg. 372/07, s. 19.

Abandonment

21. (1) A person constructing a new well that is discontinued before completion of the well's structural stage shall immediately abandon the well. O. Reg. 372/07, s. 20.

(2) The well purchaser of a new well that is dry shall immediately abandon the well unless the owner of the land on which the well is situated agrees in writing to maintain the well for future use as a well. O. Reg. 372/07, s. 20.

(3) The well owner shall immediately abandon the well if it is not being used or maintained for future use as a well. O. Reg. 372/07, s. 20.

(4) If a well produces mineralized water, the well owner shall immediately abandon the well. O. Reg. 372/07, s. 20.

(5) If a well produces water that is not potable, the well owner shall immediately abandon the well unless the well owner seeks the advice of and takes such measures directed by the local medical officer of health. O. Reg. 372/07, s. 20.

(6) If a well contains natural gas or other gas, the well owner shall immediately abandon the well unless measures are taken to manage the gas in a way that prevents any potential hazard. O. Reg. 372/07, s. 20.

(7) If a well permits any movement of natural gas, contaminants or other materials between subsurface formations, or between a subsurface formation and the ground surface, and the movement may impair the quality of any waters, the well owner shall immediately abandon the well unless measures are taken that prevent the movement at all times. O. Reg. 372/07, s. 20.

(8) If a well is constructed in contravention of any provision of this Regulation dealing with the location of wells, the methods and materials used in the construction of wells or the standards of well construction, the well owner shall immediately take steps to rectify the situation, but if those steps fail, the owner shall immediately abandon the well. O. Reg. 372/07, s. 20.

(9) The well owner shall ensure that measures taken pursuant to subsections (5) to (7) are functional at all times. O. Reg. 372/07, s. 20.

(10) Subsections (4) to (8) do not apply if the well owner has the written consent of the Director. O. Reg. 372/07, s. 20.

(11) Subsections (4) and (5) do not apply to a test hole or dewatering well. O. Reg. 372/07, s. 20.

(12) Subsections (4) and (5) do not apply to a well that,

(a) is used or intended for use as a source of water for agriculture; and

(b) is not used as a source of water for human consumption. O. Reg. 372/07, s. 20.

(13) The person abandoning the well shall retain the services of the holder of a well contractor licence, and shall ensure that the contract between them requires a well technician licensed to construct the type of well that is being abandoned to be used to abandon the well, unless,

(a) the person who works on the abandonment of the well is the owner of the land or is a member of the owner's household;

(b) the person who works on the abandonment of the well is working without remuneration for another person on land owned by the other person or by a member of the other person's household;

(c) the person who works on the abandonment of the well holds a licence referred to in paragraph 1 of subsection 5 (1); or

(d) the well is a test hole or dewatering well, the well is abandoned by a method that does not use powered equipment, and the person who works on the abandonment of the well is,

(i) a person who holds a licence referred to in paragraph 5 of subsection 5 (1), or

(ii) a person referred to in paragraph 1, 2 or 3 of section 1.0.3. O. Reg. 372/07, s. 20.

21.1 (1) If a well is abandoned, the person abandoning the well shall ensure that the following steps are taken and, unless otherwise specified, they shall be taken in the sequence in which they are set out in this subsection:

1. If the well already has a well tag, the well tag shall be removed and returned to the Director within 30 days after its removal.

2. If the well casing or well screen has collapsed, reasonable efforts shall be made to remove it, and all other equipment and debris in the well shall be removed.

3. The well, including any annular space, shall be plugged by,

   i. in the case of any well, placing a continuous column of an abandonment barrier from the bottom of the well upward to approximately two metres below the ground surface so that it prevents any movement of water, natural gas, contaminants or other material between subsurface formations or between a subsurface formation and the top of the abandonment barrier, or

   ii. in the case of a well that is greater than 65.0 centimetres in diameter, placing a continuous column of an abandonment barrier by taking the steps described in subsection (5) until the materials placed in the well under that subsection reach to approximately two metres below the ground surface.

4. If a well casing or well screen was not removed under paragraph 2, it shall be removed, where reasonably possible, during the taking of the steps required by paragraph 3, with the bottom of the casing immersed in the rising accumulation of the abandonment barrier until the required level has been reached.

5. If a well casing or well screen was not removed under paragraph 2 or 4, it shall be removed, where reasonably possible, to a minimum depth of two metres below the ground surface.

6. If an abandonment barrier placed under paragraph 3 contains cement, it shall be allowed to set until firm and, if necessary, it shall be topped up to approximately two metres below the ground surface.

7. Unless to do so may cause remaining structures to be destabilized, damaged or unsafe, below ground concrete structures, foundations and slabs shall be removed, at any time before the steps required by paragraph 8 are taken, at least to a depth adequate to accommodate the sealing measures described in paragraph 8.

8. The well shall be sealed at the ground surface by,

    i. placing between 50 and 150 centimetres in vertical thickness of bentonite chips, pellets, granules or powder in the well opening in accordance with the manufacturer's specifications, and

    ii. fill the remaining well opening to the ground surface with soil cover, or other material that is more in keeping with the surface material immediately adjacent to the well opening, to prevent inadvertent or unauthorized access.

9. The disturbed area shall be stabilized to prevent erosion. O. Reg. 372/07, s. 20.

(2) Paragraphs 2, 4 and 5 of subsection (1) do not apply to a person who abandons a well by overdrilling the entire well. O. Reg. 372/07, s. 20.

(3) The following rules apply for the purpose of subparagraphs 3 i and ii of subsection (1):

1. The abandonment barrier must be compatible with the quality of the water found in the well.

2. The abandonment barrier must not contain any materials that may impair the integrity of the abandonment barrier, including soil or drill cuttings.

3. If the well is in contact with contaminants, the abandonment barrier must be stable in the presence of the contaminants.

4. If the well is less than or equal to 6.5 centimetres in diameter and the well casing and well screen have been removed under paragraph 2 of subsection (1) or are being removed under paragraph 4 or 5 of subsection (1), the abandonment barrier must be,

    i. a slurry consisting of clean water, Portland cement and not more than 5 per cent bentonite solids by weight, or

    ii. a slurry consisting of clean water and at least 20 per cent bentonite solids by weight, and the abandonment barrier must be placed using a tremie pipe, with the bottom of the tremie pipe immersed in the rising accumulation of the abandonment barrier until the required level has been reached.

5. Paragraph 4 also applies, with necessary modifications, to an uncased well that is less than or equal to 6.5 centimetres in diameter.

6. If the well is less than or equal to 6.5 centimetres in diameter and the well casing and well screen have not been removed under paragraph 2 of subsection (1) and are not being removed under paragraph 4 or 5 of subsection (1), the abandonment barrier must be,

    i. a slurry consisting of clean water, Portland cement and not more than 5 per cent bentonite solids by weight, or

    ii. bentonite chips or pellets that have been screened and placed in accordance with the manufacturer's specifications.

7. If the well is more than 6.5 centimetres in diameter, the abandonment barrier must be,
   - i. a slurry consisting of clean water and at least 20 per cent bentonite solids by weight,
   - ii. a slurry consisting of clean water, Portland cement and not more than 5 per cent bentonite,
   - iii. a slurry consisting of clean water and Portland cement,
   - iv. a slurry consisting of clean water, Portland cement and clean sand,
   - v. a slurry consisting of equal weights of Portland cement and clean gravel, mixed with clean water,
   - vi. a slurry (sometimes called a concrete slurry) consisting of clean water, Portland cement, clean sand and clean gravel,
   - vii. bentonite chips or pellets that have been screened and placed in accordance with the manufacturer's specifications, or
   - viii. other material approved in writing by the Director, if the Director is of the opinion that the performance of the other material is the equivalent of the performance of a slurry referred to in subparagraphs i to vi.
8. A wet abandonment barrier for a well that is more than 6.5 centimetres in diameter shall be placed using a tremie pipe, with the bottom of the tremie pipe immersed in the rising accumulation of the abandonment barrier until the required level has been reached. O. Reg. 372/07, s. 20.

(4) Subparagraph 3 i of subsection (1) and subsection (3) do not prevent the placing of clean, washed sand or gravel in the well bore, adjacent to water producing zones or fractures, to minimize the loss of sealant material. O. Reg. 372/07, s. 20.

(5) The steps referred to in subparagraph 3 ii of subsection (1) with respect to a well that is greater than 65.0 centimetres in diameter, which shall be taken in the sequence in which they are set out in this subsection, are the following:

1. Clean sand or pea gravel shall be placed from the bottom of the well to the top of the deepest water producing zone or the top of the well screen, whichever is deeper.
2. At least 0.1 metre of bentonite chips or pellets shall be placed over the sand or pea gravel.
3. If the water level can be drawn down to the top of the bentonite chips or pellets,
   - i. the water level shall be drawn down to the top of the bentonite chips or pellets,
   - ii. at least 0.3 metres of a bentonite slurry that consists of clean water and at least 20 per cent bentonite solids and that is compatible with the quality of the water found in the well shall be placed over the bentonite chips or pellets, and
   - iii. clean gravel, sand, silt or clay shall be dropped over the bentonite slurry to fill the remainder of the well, while maintaining at least 0.3 metres of the bentonite slurry above the rising accumulation of gravel, sand, silt or clay.

4. If the water level cannot be drawn down to the top of the bentonite chips or pellets, the remainder of the well shall be filled to approximately two metres below the ground surface with an abandonment barrier, which may be interspersed with clean sand or pea gravel placed in each water producing zone of the well. O. Reg. 372/07, s. 20.

(6) If the well is greater than 65.0 centimetres in diameter, the person abandoning the well shall ensure that sealing materials are selected and placed for the purpose of paragraphs 3 and 8 of subsection (1) so that they will provide the appropriate structural strength to support the weight of persons and vehicles that may move over the area after it is filled. O. Reg. 372/07, s. 20.

(7) If the well is a flowing well, commercially manufactured drilling mud that does not impair the quality of the water with which it comes in contact may be used, in taking the steps required by subsection (1), to assist with drilling or placement of an abandonment barrier, but the drilling mud may not be used as an abandonment barrier. O. Reg. 372/07, s. 20.

(8) Paragraphs 2 to 9 of subsection (1) and subsections (3) to (7) do not apply to a person who abandons a well by excavation of the entire well in the course of work carried out for another purpose. O. Reg. 372/07, s. 20.

(9) This section also applies, with necessary modifications, to a well pit and, for that purpose, a reference in subsections (1) to (8) to a well shall be deemed to be a reference to a well pit. O. Reg. 372/07, s. 20.

Protection of Well Tag

22. (1) No person shall use a well tag obtained from the Ministry, except in accordance with this Regulation. O. Reg. 128/03, s. 24.

(2) No person shall remove a well tag affixed in accordance with this Regulation, except,

(a) in accordance with subsection 14.11 (3) or (4) or paragraph 1 of subsection 21.1 (1); or

(b) with the written consent of the Director. O. Reg. 128/03, s. 24; O. Reg. 372/07, s. 21.

(3) No person shall deface, alter, conceal or obstruct a well tag affixed in accordance with this Regulation. O. Reg. 128/03, s. 24.

FORMS 1-9 Revoked: O. Reg. 128/03, s. 25.

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Loi sur les ressources en eau de l'Ontario

R.R.O. 1990, RÈGLEMENT 903

PUITS

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SAUTER LE SOMMAIRE

SOMMAIRE

Definitions

1. (1) Les définitions qui suivent s'appliquent au présent règlement.

«acheteur de puits» Personne qui conclut un contrat en vue de faire construire un puits avec une personne qui exploite une entreprise de construction de puits. («well purchaser»)

«aide-technicien en construction de puits» Personne qui travaille à la construction de puits à titre d'employé ou de mandataire du titulaire d'une licence d'entrepreneur en construction de puits, sous la supervision du titulaire d'une licence de technicien en construction de puits. («assistant well technician»)

«ASTM» La société ASTM International. («ASTM»)

«AWWA» L'American Water Works Association. («AWWA»)

«bentonite» Matériau d'obturation, produit sur une base commerciale, à utiliser lors de la construction ou de l'abandon de puits et qui remplit les conditions suivantes :

a) il est composé de plus de 50 pour cent en poids de montmorillonite sodique;

b) il a la capacité de gonfler au contact de l'eau;

c) il ne fournit pas de nutriments pour les bactéries;

d) il ne dégrade pas la qualité de l'eau avec laquelle il entre en contact. («bentonite»)

«chloré» Désinfecté à l'aide de chlore résiduel libre. («chlorinated»)

«couverture» Matières non consolidées recouvrant la roche-mère. («overburden»)

«eau minéralisée» Eau contenant, par litre, plus de 6 000 milligrammes de matières totales dissoutes, plus de 500 milligrammes de chlorures ou plus de 500 milligrammes de sulfates. («mineralized water»)

«espace annulaire» Espace ouvert entre le tubage ou le filtre et la paroi d'un puits, y compris l'espace entre les tubages superposés au sein du puits. («annular space»)

«évent» Conduite dans la partie supérieure du tubage de puits qui permet l'égalisation des pressions d'air entre l'intérieur du tubage et l'atmosphère, ainsi que le dégagement des gaz se trouvant à l'intérieur du puits. («air vent»)

«filtre de puits» Tuyau ou tube perforé, tuiles en béton non étanches ou autres matériaux installés dans un puits pour filtrer la matière particulaire et former la zone de prise d'eau. («well screen»)

«formation aquifère» Formation contenant de l'eau et pouvant en fournir des quantités suffisantes pour servir de source d'approvisionnement en eau. («aquifer»)

«formation souterraine» S'entend notamment d'une formation aquifère. («subsurface formation»)

«groupe de puits» Groupe de puits pour lequel le constructeur peut dresser un seul registre de puits en vertu du paragraphe 16.4 (1). («well cluster»)

«matériau d'étanchéité» S'entend, selon le cas :

a) d'un coulis consistant en de l'eau propre et en au moins 20 pour cent en poids de bentonite sous forme solide;

b) d'un autre matériau équivalent au coulis visé à l'alinéa a) quant à sa capacité à former une barrière étanche permanente. («sealant»)

«matériau d'étanchéité approprié» Matériau d'étanchéité qui est compatible avec la qualité de l'eau du puits. («suitable sealant»)

«modification mineure» Relativement à un puits, s'entend de ce qui suit :

a) les réparations et l'entretien courants;

b) l'installation de matériel de surveillance, d'échantillonnage ou d'analyse, sauf s'il sert à vérifier le débit du puits ou de la formation aquifère;

c) l'installation d'une pompe dans un trou d'essai;

d) l'installation d'un bouchon de puits ou d'un couvercle de puits étanche. («minor alteration»)

«niveau hydrostatique» Niveau atteint par l'eau à l'état stable dans un puits lorsque aucune eau n'est retirée du puits. («static water level»)

«pompe» S'entend en outre du matériel de pompage connexe. («pump»)

«propriétaire de puits» Propriétaire du bien-fonds sur lequel un puits est situé. S'entend en outre du tenant ou du locataire du bien-fonds et de l'acheteur du puits. («well owner»)

«puits d'exhaure» Puits qui ne sert pas ou n'est pas conçu pour servir de source d'eau pour l'agriculture ou la consommation humaine et qui est érigé :

a) soit pour abaisser ou contrôler le niveau de l'eau souterraine à proximité du puits;

b) soit pour enlever des matières pouvant se trouver dans l'eau souterraine. («dewatering well»)

«puits jaillissant» Puits dont le niveau hydrostatique se situe au-dessus de la surface du sol. («flowing well»)

«registre de puits» Formule que fournit le ministère pour consigner les renseignements concernant un puits au cours de sa construction ou de son abandon. («well record»)

«roche-mère» S'entend :

a) soit de la roche solide se trouvant sous les matières non consolidées comme le gravier, le sable, le limon et l'argile;

b) soit de la roche solide se trouvant à la surface du sol. («bedrock»)

«trou d'essai» S'entend d'un puits qui :

a) d'une part, est creusé afin d'analyser des eaux souterraines ou une formation aquifère ou afin d'obtenir des renseignements à leur égard;

b) d'autre part, ne sert pas ou n'est pas conçu pour servir de source d'eau pour l'agriculture ou la consommation humaine. («test hole»)

«tubage» Tuyaux, tubes ou autres matériaux installés dans un puits afin d'en supporter les parois, à l'exclusion toutefois des filtres de puits. («casing»)

«tuyau à trémie» Tuyau ou tube dont le diamètre interne correspond à au moins le triple de celui de la particule de matière la plus grande qui passe à travers et qui sert à amener des matières jusqu'au fond d'un trou, notamment un trou contenant de l'eau stagnante. («tremie pipe») Règl. de l'Ont. 389/09, art. 1.

(2) Pour l'application du présent règlement :

a) est constructeur d'un puits le technicien en construction de puits ou tout autre particulier qui travaille à sa construction;

b) l'acheteur d'un puits n'est pas constructeur d'un puits. Règl. de l'Ont. 389/09, art. 1.

(3) Pour l'application du présent règlement, les travaux de construction d'un puits sont achevés le jour où le puits peut être utilisé aux fins pour lesquelles il a été construit sauf pour ce qui suit :

a) l'observation de l'article 15;

b) l'installation d'une pompe;

c) toute modification nécessaire à l’installation de matériel de pompage, de surveillance, d’échantillonnage ou d’analyse ou de matériel de traitement de l’eau. Règl. de l’Ont. 389/09, art. 1.

EXEMPTIONS

1.0.1 Les articles 36 à 50 de la Loi et le présent règlement ne s’appliquent pas aux éléments suivants qui font fonction de puits :

1. Les étangs.
2. Les réservoirs.
3. Les lagunes.
4. Les marais artificiels.
5. Les canaux.
6. Les caniveaux.
7. Les drains en tuyaux.
8. Les drains géotextiles.
9. Les fossés. Règl. de l’Ont. 389/09, art. 1.

1.0.2 Les articles 36 à 50 de la Loi et le présent règlement ne s’appliquent pas aux activités suivantes qui font partie de la construction d’un puits :

1. L’inspection du puits à l’aide de matériel qui n’est pas laissé sans surveillance dans le puits.
2. La surveillance, l’échantillonnage ou l’analyse du puits à l’aide de matériel qui, selon le cas :
   i. ne sert pas à vérifier le débit du puits ou de la formation aquifère et n’est pas laissé sans surveillance dans le puits,
   ii. ne sert pas à vérifier le débit du puits ou de la formation aquifère et a été installé antérieurement dans le puits.
3. L’installation de matériel de surveillance, d’échantillonnage ou d’analyse d’un trou d’essai ou d’un puits d’exhaure, sauf si, selon le cas :
   i. l’installation nécessite une modification du puits autre que l’encochage du haut du tubage,
   ii. le matériel sert à vérifier le débit du puits ou de la formation aquifère. Règl. de l’Ont. 389/09, art. 1.

1.0.3 L’article 43 de la Loi ne s’applique pas aux personnes suivantes qui exercent les activités visées à la disposition 5 du paragraphe 5 (1) pour le titulaire d’une licence d’entrepreneur en construction de puits :

1. Les titulaires d’un permis, d’un permis restreint ou d’un permis temporaire au sens de la *Loi sur les ingénieurs*.

2. Les titulaires d’un certificat d’inscription visé par la *Loi de 2000 sur les géoscientifiques professionnels* qui sont des membres en exercice, des membres temporaires ou des membres restreints de l’Ordre des géoscientifiques professionnels de l’Ontario.
3. Les personnes qui sont inscrites en vertu du paragraphe 8 (2) de la loi intitulée *Ontario Association of Certified Engineering Technicians and Technologists Act, 1998*, qui constitue le chapitre Pr7, et qui sont des membres ordinaires de l’association prorogée en application de cette loi. Règl. de l’Ont. 389/09, art. 1.

OUVRAGES PEU PROFONDS

1.1 (1) Le trou d’essai ou le puits d’exhaure qui est creusé jusqu’à une profondeur maximale de 3 mètres sous la surface du sol est soustrait à l’application des articles 36 à 50 de la Loi et du présent règlement, sauf si, selon le cas :

a) il est construit dans une zone contaminée;

b) il est construit dans une zone dont les conditions entraîneront vraisemblablement des puits jaillissants;

c) il pénètre dans une formation qui n’est pas une formation aquifère. Règl. de l’Ont. 389/09, art. 1.

(2) Malgré le paragraphe (1), le constructeur d’un trou d’essai ou d’un puits d’exhaure visé à ce paragraphe veille à ce qui suit :

a) les horizons majeurs du sol sont excavés et entreposés séparément, tenus à l’abri de la contamination et, lorsque le trou ou le puits n’est plus utilisé ou entretenu en vue d’un usage futur en tant que puits, remblayés dans les mêmes positions relatives qu’ils occupaient au départ;

b) lorsque le trou ou le puits n’est plus utilisé ou entretenu en vue d’un usage futur en tant que puits, il est remblayé avec un matériau d’obturation en bentonite sèche produit sur une base commerciale ou un autre matériau d’étanchéité approprié, ou encore avec du sol propre non contaminé dont la granulométrie est la même que celle du sol excavé au départ ou plus fine qu’elle. Règl. de l’Ont. 389/09, art. 1.

(3) S’il devient apparent, au cours de la construction, de l’utilisation ou de l’abandon d’un trou d’essai ou d’un puits d’exhaure, que le paragraphe (1) ne s’applique pas, la personne qui l’a fait construire retient les services du titulaire d’une licence d’entrepreneur en construction de puits, sauf si le paragraphe (4) s’applique. Règl. de l’Ont. 389/09, art. 1.

(4) Le propriétaire du puits retient les services du titulaire d’une licence d’entrepreneur en construction de puits si les conditions suivantes sont réunies :

a) les travaux de construction d’un trou d’essai ou d’un puits d’exhaure sont achevés;

b) le propriétaire du puits a pris le contrôle de l’exploitation du trou d’essai ou du puits d’exhaure;

c) il devient apparent, au cours de l’utilisation ou de l’abandon du trou d’essai ou du puits d’exhaure, que le paragraphe (1) ne s’applique pas. Règl. de l’Ont. 389/09, art. 1.

(5) Le titulaire d'une licence d'entrepreneur en construction de puits dont les services sont retenus en application du paragraphe (3) ou (4) veille à l'observation de la Loi, du présent règlement et de la *Loi sur la protection de l'environnement*. Règl. de l'Ont. 389/09, art. 1.

(6) Les paragraphes (3) et (4) ne s'appliquent pas si la personne qui serait par ailleurs tenue de retenir les services du titulaire d'une licence d'entrepreneur en construction de puits a à son service un employé qui est titulaire d'une licence de technicien en construction de puits et qui veille à l'observation de la Loi, du présent règlement et de la *Loi sur la protection de l'environnement*. Règl. de l'Ont. 389/09, art. 1.

LICENCE D'ENTREPRENEUR EN CONSTRUCTION DE PUITS

2. (1) La demande de licence d'entrepreneur en construction de puits est rédigée selon la formule que fournit le ministère et est accompagnée des droits exigés. Règl. de l'Ont. 389/09, art. 1.

(2) La demande de renouvellement d'une licence d'entrepreneur en construction de puits est rédigée selon la formule que fournit le ministère et est accompagnée des droits exigés. Règl. de l'Ont. 389/09, art. 1.

(3) Si l'auteur de la demande est une société ou une société de personnes, la demande est remplie et signée par les représentants officiels visés à la disposition 1 de l'article 4. Règl. de l'Ont. 389/09, art. 1.

3. (1) L'auteur d'une demande de licence d'entrepreneur en construction de puits ou de renouvellement d'une telle licence ou, s'il s'agit d'une société ou d'une société de personnes, un de ses associés ou administrateurs doit être âgé de 18 ans ou plus. Règl. de l'Ont. 389/09, art. 1.

(2) L'auteur d'une demande de licence d'entrepreneur en construction de puits ou de renouvellement d'une telle licence présente les renseignements et les documents que le directeur peut raisonnablement exiger afin de le convaincre de la moralité, des qualités et de la responsabilité financière de l'auteur de la demande ou de ses dirigeants et administrateurs. Règl. de l'Ont. 389/09, art. 1.

(3) Le titulaire d'une licence d'entrepreneur en construction de puits avise par écrit le directeur, dans les 10 jours, de tout changement apporté aux renseignements présentés en application de l'article 2 ou du paragraphe (2). Règl. de l'Ont. 389/09, art. 1.

4. Toute licence d'entrepreneur en construction de puits est assortie des conditions prescrites suivantes :

1. Si le titulaire de la licence est une société ou une société de personnes, il veille :
   i. d'une part, à ce qu'au moins un administrateur, un dirigeant ou un associé soit désigné en tout temps comme son représentant officiel,
   ii. d'autre part, à ce que les représentants officiels aient été chargés d'assurer l'observation de la Loi et du présent règlement.
2. Pour chaque entreprise de construction de puits qu'il exploite, le titulaire de la licence maintient en vigueur une assurance, en la forme approuvée par le surintendant des services financiers de la province de l'Ontario, à l'égard de sa responsabilité et de celle de ses employés et mandataires découlant de l'entreprise, pour les montants suivants :

i. au moins 2 000 000 $ pour les dommages matériels résultant d’un incident donné,

ii. au moins 2 000 000 $ pour le décès de toute personne qui n’est pas un employé du titulaire de la licence ou pour les blessures corporelles subies par elle.

Toutefois, le contrat d’assurance peut à la fois :

iii. limiter à 5 000 000 $ la responsabilité de l’assureur découlant d’un incident donné en vertu du contrat,

iv. prévoir que l’assuré assumera une franchise maximale de 1 000 $ pour chaque demande d’indemnité à l’égard de laquelle une garantie est exigée.

3. Le titulaire de la licence ne doit effectuer ou faire effectuer des travaux de construction de puits que s’ils sont effectués ou supervisés par l’une ou l’autre des personnes suivantes :

i. lui-même, s’il est également titulaire d’une licence de technicien en construction de puits qui agit dans les limites de cette licence,

ii. un de ses associés, si le titulaire de la licence est une société de personnes et que l’associé est titulaire d’une licence de technicien en construction de puits qui agit dans les limites de cette licence,

iii. un de ses dirigeants ou administrateurs, si le titulaire de la licence est une société et que le dirigeant ou l’administrateur est titulaire d’une licence de technicien en construction de puits qui agit dans les limites de cette licence,

iv. un de ses employés ou mandataires, si l’employé ou le mandataire est titulaire d’une licence de technicien en construction de puits qui agit dans les limites de cette licence,

v. si les travaux ne concernent que les activités visées à la disposition 5 du paragraphe 5 (1), une personne visée à la disposition 1, 2 ou 3 de l’article 1.0.3.

4. **Disposition abrogée avant l’ajout de la version française du règlement**. **Règl. de l’Ont. 128/03, par. 5 (2).**

5. Le titulaire de la licence se conforme aux exigences de la Loi et du présent règlement et veille à ce que ses employés et mandataires fassent de même. Règl. de l’Ont. 389/09, art. 1.

LICENCE DE TECHNICIEN EN CONSTRUCTION DE PUITS

5. (1) Les catégories suivantes de licences de technicien en construction de puits sont prescrites :

1. Forage de puits à la sondeuse – Licence autorisant son titulaire à construire des puits au moyen de matériel de forage de puits, y compris le matériel suivant, et à en superviser la construction :

i. le matériel de forage rotatif (standard, à circulation inverse, pneumatique, à la boue et par percussion pneumatique),

ii. l’outillage de forage au câble (par battage ou percussion),

iii. le matériel de forage au diamant.

2. Creusage et forage de puits à la tarière – Licence autorisant son titulaire à construire des puits au moyen de matériel de creusage non mécanique ou d'une pelle rétrocaveuse ou hydraulique et au moyen d'une tarière, et à en superviser la construction.

3. Autre construction de puits – Licence autorisant son titulaire à construire des puits ou un type de puits indiqué dans la licence uniquement au moyen des méthodes ou du matériel précisés dans la licence, et à en superviser la construction.

4. Installation de pompes – Licence autorisant son titulaire à installer des pompes dans un puits, ou reliées à un puits, et à en superviser l'installation.

5. Surveillance, échantillonnage, analyse et construction au moyen de matériel non mécanique – Licence autorisant son titulaire à faire ce qui suit :

   i. installer du matériel de surveillance, d'échantillonnage ou d'analyse dans un puits, et en superviser l'installation, sauf s'il s'agit de matériel servant à vérifier le débit du puits ou de la formation aquifère,

   ii. installer des pompes dans un trou d'essai ou un puits d'exhaure aux fins de surveillance, d'échantillonnage ou d'analyse, et en superviser l'installation,

   iii. construire des trous d'essai et des puits d'exhaure par toute méthode qui ne fait pas appel à du matériel mécanique, et en superviser la construction. Règl. de l'Ont. 389/09, art. 1.

(1.1) La licence visée à la disposition 1 ou 2 du paragraphe (1) :

a) d'une part, n'autorise pas son titulaire à exercer les activités visées à la disposition 4 ou à la sous-disposition 5 i ou ii du paragraphe (1);

b) d'autre part, autorise son titulaire à exercer les activités visées à la sous-disposition 5 iii du paragraphe (1). Règl. de l'Ont. 389/09, art. 1.

(1.2) La licence visée à la disposition 3 du paragraphe (1) n'autorise son titulaire qu'à exercer les activités précisées dans la licence. Règl. de l'Ont. 389/09, art. 1.

(1.3) La licence visée à la disposition 4 du paragraphe (1) autorise son titulaire à exercer les activités visées aux sous-dispositions 5 i et ii du paragraphe (1). Règl. de l'Ont. 389/09, art. 1.

(2) La demande de licence de technicien en construction de puits est rédigée selon la formule que fournit le ministère et est accompagnée des droits exigés. Règl. de l'Ont. 389/09, art. 1.

(3) La demande de renouvellement d'une licence de technicien en construction de puits est rédigée selon la formule que fournit le ministère et est accompagnée des droits exigés. Règl. de l'Ont. 389/09, art. 1.

(4) à (8) **Dispositions abrogées avant l'ajout de la version française du règlement. Règl. de l'Ont. 128/03, par. 6 (2).**

6. (1) L'auteur d'une demande de licence de technicien en construction de puits doit être âgé de 18 ans ou plus. Règl. de l'Ont. 389/09, art. 1.

(2) L'auteur d'une demande de licence de technicien en construction de puits ou de renouvellement d'une telle licence présente les renseignements et les documents que le directeur peut

raisonnablement exiger afin de le convaincre de la moralité, des qualités et de la compétence de l'auteur de la demande. Règl. de l'Ont. 389/09, art. 1.

(3) Les qualités suivantes sont prescrites à l'égard de l'auteur d'une demande de licence de technicien en construction de puits d'une catégorie visée à la disposition 1, 2, 3 ou 4 du paragraphe 5 (1) :

1. La réussite à un programme d'études d'au moins 30 heures qui est approuvé par le directeur pour la catégorie de licence de technicien en construction de puits demandée.
2. Quatre mille heures d'expérience professionnelle passées à exercer ou à aider à exercer l'activité qui serait autorisée par la licence demandée, ou une combinaison d'expérience professionnelle et d'autres qualités que le directeur estime équivalente. Règl. de l'Ont. 389/09, art. 1.

(3.1) Les qualités suivantes sont prescrites à l'égard de l'auteur d'une demande de licence de technicien en construction de puits de la catégorie visée à la disposition 5 du paragraphe 5 (1) :

1. Dans le cas de l'auteur d'une demande visé au paragraphe (3.2) :
   i. la réussite à un programme d'études d'au moins 15 heures qui est approuvé par le directeur pour la catégorie de licence de technicien en construction de puits visée à la disposition 5 du paragraphe 5 (1),
   ii. cinq cents heures d'expérience professionnelle passées à exercer ou à aider à exercer l'activité qui serait autorisée par la licence demandée, ou une combinaison d'expérience professionnelle et d'autres qualités que le directeur estime équivalente.
2. Dans les autres cas :
   i. la réussite à un programme d'études d'au moins 30 heures qui est approuvé par le directeur pour la catégorie de licence de technicien en construction de puits visée à la disposition 5 du paragraphe 5 (1),
   ii. mille heures d'expérience professionnelle passées à exercer ou à aider à exercer l'activité qui serait autorisée par la licence demandée, ou une combinaison d'expérience professionnelle et d'autres qualités que le directeur estime équivalente. Règl. de l'Ont. 389/09, art. 1.

(3.2) La disposition 1 du paragraphe (3.1) s'applique à l'auteur d'une demande qui, selon le cas :

a) est membre de l'Ordre des ingénieurs de l'Ontario à titre d'ingénieur en formation;

b) est membre de l'Ordre des géoscientifiques professionnels de l'Ontario à titre de géoscientifique en formation;

c) est membre de l'association appelée Ontario Association of Certified Engineering Technicians and Technologists à titre de technicien ou de technologiste en formation. Règl. de l'Ont. 389/09, art. 1.

(4) Le titulaire d’une licence de technicien en construction de puits avise par écrit le directeur, dans les 10 jours, de tout changement apporté aux renseignements présentés en application de l’article 5 ou du paragraphe (2). Règl. de l’Ont. 389/09, art. 1.

7. Toute licence de technicien en construction de puits est assortie des conditions prescrites suivantes :

0.1 Le titulaire de la licence n’effectue ou ne supervise les travaux de construction d’un puits que si, selon le cas :

   i. les travaux sont effectués pour le titulaire d’une licence d’entrepreneur en construction de puits,

   ii. les travaux sont effectués pour un ministère de la Couronne et le titulaire de la licence est employé au sein du ministère.

1. Le titulaire de la licence ne doit pas superviser le fonctionnement de plus de deux unités de matériel de construction de puits à la fois.
2. Le titulaire de la licence n’effectue ou ne supervise les travaux de construction d’un puits que suivant les autorisations expresses de sa licence.
3. Lorsqu’il effectue ou supervise des travaux afférents à la construction de puits, le titulaire de la licence a en sa possession une copie de sa licence et le présente à tout employé ou mandataire du ministère qui lui en fait la demande.
4. Le titulaire de la licence se conforme aux exigences de la Loi et du présent règlement et veille à ce que chaque personne qu’il supervise fasse de même.
5. Promptement après la réception de sa licence, le titulaire de celle-ci rend au directeur toute carte d’identité d’aide-technicien en construction de puits qui lui avait été délivrée en application du présent règlement. Règl. de l’Ont. 389/09, art. 1.

EXAMEN

8. (1) Tout auteur d’une demande de licence d’entrepreneur en construction de puits ou de licence de technicien en construction de puits passe un examen établi par le directeur. Règl. de l’Ont. 389/09, art. 1.

(1.1) Pour l’application du paragraphe (1), le directeur peut établir des examens distincts pour différentes catégories d’auteurs de demande et de licences. Règl. de l’Ont. 389/09, art. 1.

(2) Si l’auteur d’une demande de licence d’entrepreneur en construction de puits est une société ou une société de personnes, chacun des représentants officiels visés à la disposition 1 de l’article 4 passe l’examen exigé par le paragraphe (1). Règl. de l’Ont. 389/09, art. 1.

(3) La demande de rendez-vous pour passer l’examen est rédigée selon la formule que fournit le ministère et est accompagnée des droits exigés. Règl. de l’Ont. 389/09, art. 1.

(4) **Disposition abrogée avant l’ajout de la version française du règlement. Règl. de l’Ont. 128/03, art. 9.**

(5) L'auteur d'une demande qui a acquitté les droits est avisé au moins sept jours à l'avance des date, heure et lieu fixés pour l'examen. Règl. de l'Ont. 389/09, art. 1.

(6) Nul auteur d'une demande ne peut se présenter à un examen pour la même licence plus de quatre fois au cours d'une période de 12 mois. Règl. de l'Ont. 389/09, art. 1.

(7) Pour l'application du paragraphe (6), l'auteur d'une demande qui a obtenu un rendez-vous pour passer un examen, mais qui ne s'y présente pas, est réputé s'y être présenté. Règl. de l'Ont. 389/09, art. 1.

FORMATION PERMANENTE – TECHNICIENS EN CONSTRUCTION DE PUITS

8.1 (1) Le renouvellement d'une licence de technicien en construction de puits visée à la disposition 1, 2, 3 ou 4 du paragraphe 5 (1) n'est accordé que si l'auteur de la demande a terminé avec succès des cours de formation permanente, approuvés par le directeur, consistant en au moins 21 heures d'instruction au cours de la période qui se termine à la date de présentation de la demande et qui a commencé à celle des dates suivantes qui est postérieure à l'autre :

1. Le 1er janvier de la troisième année civile qui précède celle au cours de laquelle la licence expire.
2. Le dernier jour d'instruction dans un cours de formation permanente auquel l'auteur de la demande s'est déjà fié pour l'application du présent paragraphe et qui s'est terminé au cours de la troisième année civile qui précède celle au cours de laquelle la licence expire. Règl. de l'Ont. 389/09, art. 1.

(2) Le renouvellement d'une licence de technicien en construction de puits visée à la disposition 5 du paragraphe 5 (1) n'est accordé que si l'auteur de la demande a terminé avec succès des cours de formation permanente, approuvés par le directeur, consistant en au moins 14 heures d'instruction au cours de la période qui se termine à la date de présentation de la demande et qui a commencé à celle des dates suivantes qui est postérieure à l'autre :

1. Le 1er janvier de la troisième année civile qui précède celle au cours de laquelle la licence expire.
2. Le dernier jour d'instruction dans un cours de formation permanente auquel l'auteur de la demande s'est déjà fié pour l'application du présent paragraphe et qui s'est terminé au cours de la troisième année civile qui précède celle au cours de laquelle la licence expire. Règl. de l'Ont. 389/09, art. 1.

(3) Si une licence de technicien en construction de puits est renouvelée au cours d'une année civile, le paragraphe (1) ou (2) ne s'applique pas à un renouvellement subséquent qui a lieu au cours des deux années civiles qui suivent. Règl. de l'Ont. 389/09, art. 1.

AIDE-TECHNICIEN EN CONSTRUCTION DE PUITS

9. (1) L'aide-technicien en construction de puits qui ne possède pas de carte d'identité délivrée en vertu du présent article est soustrait à l'application de l'article 43 de la Loi lorsqu'il travaille à la construction de puits s'il est supervisé par le titulaire d'une licence de technicien en construction de puits qui se trouve sur les lieux. Règl. de l'Ont. 389/09, art. 1.

(2) L'aide-technicien en construction de puits qui possède une carte d'identité délivrée en vertu du présent article est soustrait à l'application de l'article 43 de la Loi lorsqu'il travaille à la construction de puits pour le compte du titulaire de licence dont le nom figure sur la carte si les conditions suivantes sont réunies :

a) la date d'expiration de la carte n'a pas encore été atteinte;

b) l'aide-technicien porte la carte sur lui et la présente à la demande d'un employé ou mandataire du ministère;

c) l'aide-technicien est supervisé par le titulaire d'une licence de technicien en construction de puits qui est en mesure de se présenter sur les lieux à une heure d'avis. Règl. de l'Ont. 389/09, art. 1.

(3) Au plus tôt quatre mois après qu'un aide-technicien en construction de puits a commencé à travailler comme employé ou mandataire du titulaire d'une licence d'entrepreneur en construction de puits, ce dernier peut demander au directeur, selon la formule que fournit le ministère, de délivrer une carte d'identité pour l'aide-technicien. Règl. de l'Ont. 389/09, art. 1.

(4) Lorsque la carte d'identité de l'aide-technicien en construction de puits est sur le point d'expirer, le titulaire d'une licence d'entrepreneur en construction de puits peut demander au directeur, selon la formule que fournit le ministère, de délivrer une nouvelle carte d'identité pour l'aide-technicien. Règl. de l'Ont. 389/09, art. 1.

(5) La carte d'identité délivrée pour un aide-technicien en construction de puits en vertu du présent article porte une date d'expiration qui ne tombe pas plus de 36 mois après la date de sa délivrance. Règl. de l'Ont. 389/09, art. 1.

(6) La personne pour laquelle une carte d'identité est délivrée rend la carte au directeur promptement après qu'elle cesse d'être l'employé ou le mandataire de l'entrepreneur titulaire d'une licence dont le nom figure sur la carte. Règl. de l'Ont. 389/09, art. 1.

10. Disposition abrogée avant l'ajout de la version française du règlement. Règl. de l'Ont. 128/03, art. 12.

11. et **11.1 Dispositions abrogées avant l'ajout de la version française du règlement. Règl. de l'Ont. 372/07, art. 10.**

EMPLACEMENT DES PUITS

12. (0.1) Tout constructeur d'un puits se conforme aux exigences du présent article. Règl. de l'Ont. 389/09, art. 1.

(1) L'emplacement d'un nouveau puits est séparé :

a) de cabinets à puisard, de voûtes de latrines, de latrines à fosse mobile, de systèmes d'évacuation des eaux ménagères ou de puisards, au sens que donne aux termes «earth pit privy», «privy vault», «pail privy», «greywater system» et «cesspool» le Règlement de l'Ontario 350/06 (Building Code) pris en application de la *Loi de 1992 sur le code du bâtiment*, par au moins la distance de dégagement applicable indiquée au tableau 8.2.1.5. de ce règlement;

b) de systèmes de traitement, de drains de distribution ou de réservoirs de rétention, au sens que donne aux termes «treatment unit», «distribution pipe» et «holding tank» le Règlement de l'Ontario 350/06, par au moins la distance de dégagement applicable indiquée au tableau 8.2.1.6.A., 8.2.1.6.B. ou 8.2.1.6.C. de ce règlement. Règl. de l'Ont. 389/09, art. 1.

(1.1) La mention, au paragraphe (1), de cabinets à puisard, de voûtes de latrines, de latrines à fosse mobile, de systèmes d'évacuation des eaux ménagères, de puisards, de systèmes de traitement, de drains de distribution et de réservoirs de rétention vaut mention de ces éléments même s'ils n'ont pas été construits si un permis de construire a été délivré à leur égard. Règl. de l'Ont. 389/09, art. 1.

(2) L'emplacement d'un nouveau puits foré à la sondeuse qui est pourvu d'un tubage jusqu'à une profondeur de plus de six mètres sous le niveau du sol est éloigné d'au moins 15 mètres d'une source de contamination autre que celles visées au paragraphe (1). Règl. de l'Ont. 389/09, art. 1.

(3) Est éloigné d'au moins 30 mètres d'une source de contamination autre que celles visées au paragraphe (1) l'emplacement :

a) d'un nouveau puits foré à la sondeuse qui n'est pas pourvu d'un tubage jusqu'à une profondeur de plus de six mètres sous le niveau du sol;

b) d'un nouveau puits qui n'est pas un puits foré à la sondeuse. Règl. de l'Ont. 389/09, art. 1.

(4) L'emplacement d'un nouveau puits est choisi de sorte que celui-ci soit accessible aux fins de nettoyage, de traitement, de réparation, de vérification, d'inspection et d'examen visuel en tout temps avant, pendant et après sa construction. Règl. de l'Ont. 389/09, art. 1.

(5) L'emplacement d'un nouveau puits est situé à une hauteur supérieure à celle du sol immédiatement adjacent. Règl. de l'Ont. 389/09, art. 1.

(6) Les paragraphes (1) à (5) ne s'appliquent ni aux trous d'essai ni aux puits d'exhaure. Règl. de l'Ont. 389/09, art. 1.

(7) Un nouveau puits ne doit pas être construit avec une fosse de visite ni une fosse de visite être ajoutée à un puits existant, à quelque emplacement que ce soit. Règl. de l'Ont. 389/09, art. 1.

(7.1) Le paragraphe (7) ne s'applique ni aux trous d'essai ni aux puits d'exhaure. Règl. de l'Ont. 389/09, art. 1.

(8) Malgré le paragraphe (7) :

a) d'une part, un nouveau puits peut être construit avec une fosse de visite s'il a été créé au moyen de matériel de forage au diamant utilisé dans le cadre de travaux d'exploration minière;

b) d'autre part, une fosse de visite peut être ajoutée à un puits existant qui a été créé au moyen de matériel de forage au diamant utilisé dans le cadre de travaux d'exploration minière. Règl. de l'Ont. 389/09, art. 1.

(9) Les exigences suivantes s'appliquent à la fosse de visite que permet le paragraphe (7.1) ou (8) :

1. L'article 13 s'applique comme si la fosse était un puits.

2. Le plancher de la fosse est recouvert d'une couche de matériau d'étanchéité approprié d'une épaisseur d'au moins 10 centimètres et qui, à l'état solide, peut supporter le poids d'une personne.

3. Le sommet de la fosse est recouvert d'un couvercle solide étanche qui empêche la pénétration, dans la fosse, des eaux de surface et d'autres matières étrangères.

4. Le couvercle de la fosse est solidement attaché de manière à ce que les enfants aient de la difficulté à le soulever.

5. La fosse est tenue au sec au moyen d'une pompe de vidange.

6. Malgré la disposition 5, si la nappe phréatique est sensiblement moins élevée que le plancher de la fosse, celle-ci peut être tenue au sec au moyen de drainage par une soupape à simple action qui passe à travers la couche de matériau d'étanchéité et qui est située près du périmètre de la fosse.

7. Le sommet du tubage du puits foré à la sondeuse se trouve à au moins 40 centimètres au-dessus du plancher de la fosse.

8. Le sommet du tubage du puits foré à la sondeuse est scellé par un joint sanitaire de fabrication commerciale et est pourvu d'un conduit d'évent suffisamment long pour passer au-dessus du couvercle de la fosse. Règl. de l'Ont. 389/09, art. 1.

(10) Les dispositions 4 à 8 du paragraphe (9) ne s'appliquent pas au trou d'essai ou au puits d'exhaure visé au paragraphe 13 (11). Règl. de l'Ont. 389/09, art. 1.

RELEVÉ ET CARNET DE NOTES

12.1 (1) Tout constructeur d'un puits et quiconque procède à l'abandon d'un puits dresse et conserve aux fins de consultation sur l'emplacement du puits :

a) d'une part, un relevé des matériaux formant la couverture et la roche-mère;

b) d'autre part, un carnet de notes comprenant un registre à jour des travaux de construction ou d'abandon du puits. Règl. de l'Ont. 389/09, art. 1.

(2) Malgré l'alinéa (1) a), n'est pas tenue de dresser un relevé des matériaux formant la couverture et la roche-mère la personne qui, selon le cas :

a) construit un puits par fonçage;

b) modifie un puits sans l'approfondir;

c) ne fait qu'installer une pompe;

d) abandonne un puits. Règl. de l'Ont. 389/09, art. 1.

RECOUVREMENT DES PUITS

12.2 Lorsqu'un puits en voie de construction est laissé sans surveillance, notamment pendant une modification mineure ou l'installation d'une pompe, le constructeur en recouvre de façon sûre la partie supérieure ouverte de manière à empêcher la pénétration, dans le puits, des eaux de surface et d'autres matières étrangères. Règl. de l'Ont. 389/09, art. 1.

DRAINAGE SUPERFICIEL

12.3 Le constructeur du puits veille à ce que le drainage superficiel empêche l'eau de s'accumuler ou de séjourner à proximité du puits. Règl. de l'Ont. 389/09, art. 1.

PROFONDEUR DES PUITS

12.4 (1) Le constructeur d'un nouveau puits construit par quelque méthode que ce soit veille à ce que le puits ait une profondeur d'au moins six mètres, sauf si un puits moins profond s'impose, vu la seule formation aquifère utilisable, auquel cas il doit avoir une profondeur d'au moins trois mètres. Règl. de l'Ont. 389/09, art. 1.

(2) Le paragraphe (1) ne s'applique ni aux trous d'essai ni aux puits d'exhaure. Règl. de l'Ont. 389/09, art. 1.

TUBAGE ET FILTRE DE PUITS

13. (0.1) Tout constructeur d'un nouveau puits se conforme aux exigences du présent article. Règl. de l'Ont. 389/09, art. 1.

(1) Le tubage et le filtre de puits sont constitués de matériaux neufs. Règl. de l'Ont. 389/09, art. 1.

(2) Le paragraphe (1) ne s'applique ni au trou d'essai ni au puits d'exhaure dont l'abandon est prévu au plus tard 180 jours après l'achèvement des travaux de construction du trou ou du puits. Règl. de l'Ont. 389/09, art. 1.

(3) Le tubage et le filtre de puits sont propres et à l'abri de toute contamination. Règl. de l'Ont. 389/09, art. 1.

(4) Le tubage et le filtre de puits ne doivent pas dégrader la qualité de l'eau avec laquelle ils entrent en contact. Règl. de l'Ont. 389/09, art. 1.

(5) Le tubage est étanche. Règl. de l'Ont. 389/09, art. 1.

(6) Tous les joints et raccords du tubage assurent une liaison étanche permanente. Règl. de l'Ont. 389/09, art. 1.

(7) Si un tubage en béton est utilisé :

a) les sections du tubage sont complètement durcies et de fabrication commerciale;

b) les sections du tubage sont alignées correctement dans le puits de sorte que les joints soient encastrés et que le tubage soit centré;

c) les sections du tubage sont jointes au moyen d'un matériau d'obturation en mastic qui demeure souple et étanche et qui est approuvé pour usage avec l'eau potable par la NSF International. Règl. de l'Ont. 389/09, art. 1.

(8) Le puits qui est alimenté à partir d'une couverture est pourvu d'un tubage allant de la zone de prise d'eau jusqu'à au moins 40 centimètres au-dessus du point le plus élevé sur la surface du sol dans un rayon de trois mètres de l'extérieur du tubage, après que le drainage superficiel est devenu

conforme aux exigences de l’article 12.3, ainsi qu’il est mesuré au moment de l’achèvement des travaux de construction du puits. Règl. de l’Ont. 389/09, art. 1.

(9) Le puits qui est alimenté à partir de la roche-mère est pourvu d’un tubage allant de la roche-mère jusqu’à au moins 40 centimètres au-dessus du point le plus élevé sur la surface du sol dans un rayon de trois mètres de l’extérieur du tubage, après que le drainage superficiel est devenu conforme aux exigences de l’article 12.3, ainsi qu’il est mesuré au moment de l’achèvement des travaux de construction du puits. Règl. de l’Ont. 389/09, art. 1.

(10) Les paragraphes (8) et (9) n’exigent pas que le tubage d’un puits tubé atteigne la hauteur visée à ces paragraphes s’il est satisfait aux conditions suivantes :

a) le puits est creusé par lançage ou fonçage;

b) le puits est pourvu d’un tubage allant du point le plus élevé sur la surface du sol dans un rayon de trois mètres de l’extérieur du tubage, après que le drainage superficiel est devenu conforme aux exigences de l’article 12.3, jusqu’à :

(i) la zone génératrice d’eau, si le puits est alimenté à partir de la couverture,

(ii) la roche-mère, si le puits est alimenté à partir de la roche-mère;

c) le sommet du tubage est situé au-dessus du sol à une hauteur suffisante pour permettre de fixer la plaque d’identification de puits;

d) l’emplacement du puits est indiqué par un repère permanent qui est visible pendant toute l’année. Règl. de l’Ont. 389/09, art. 1.

(11) Les paragraphes (8) et (9) n’exigent pas que le tubage d’un trou d’essai ou puits d’exhaure tubé soit situé au-dessus de la surface du sol s’il est satisfait aux conditions suivantes :

a) le puits est situé à un endroit où il est vraisemblable que des véhicules ou des piétons passeront directement au-dessus;

b) le puits achevé est muni d’un couvercle étanche encastré de fabrication commerciale qui empêche la pénétration, dans le puits, des eaux de surface et d’autres matières étrangères;

c) le couvercle de puits est suffisamment robuste, durable et bien installé pour protéger le puits des dommages, ou il est recouvert d’une plaque métallique qui est suffisamment grande, robuste, durable et bien installée pour protéger le couvercle et le puits des dommages. Règl. de l’Ont. 389/09, art. 1.

(11.1) Il n’est pas nécessaire qu’un trou d’essai ou un puits d’exhaure soit pourvu d’un tubage si :

a) d’une part, l’abandon du trou ou du puits est prévu au plus tard 30 jours après l’achèvement des travaux de construction du trou ou du puits;

b) d’autre part, le constructeur du puits en recouvre de façon sûre la partie supérieure ouverte de manière à empêcher la pénétration, dans le puits, des eaux de surface et d’autres matières étrangères lorsque le puits est laissé sans surveillance. Règl. de l’Ont. 389/09, art. 1.

(11.2) Malgré les paragraphes (8), (9) et (10), un puits qui doit être pourvu d'un tubage doit satisfaire aux exigences suivantes :

a) avoir un tubage d'une profondeur d'au moins six mètres sous le niveau de la surface du sol initiale, sauf si l'alinéa b) s'applique;

b) avoir un tubage d'une profondeur d'au moins 2,5 mètres sous le niveau de la surface du sol initiale, si un tubage s'étendant à six mètres sous ce niveau ne permettrait pas l'utilisation de la seule formation aquifère utilisable. Règl. de l'Ont. 389/09, art. 1.

(11.3) Le paragraphe (11.2) ne s'applique ni aux trous d'essai ni aux puits d'exhaure. Règl. de l'Ont. 389/09, art. 1.

(12) Le tubage d'un puits foré à la sondeuse qui est alimenté à partir de la roche-mère, à l'exclusion de la couche de roche-mère altérée, est scellé dans la roche-mère avec un matériau d'étanchéité approprié de manière à empêcher que la qualité de l'eau souterraine et de l'eau du puits ne se dégrade. Règl. de l'Ont. 389/09, art. 1.

(13) Le paragraphe (12) ne s'applique ni aux trous d'essai ni aux puits d'exhaure. Règl. de l'Ont. 389/09, art. 1.

(14) Si un puits est construit avec une fosse de visite conformément au paragraphe 12 (8) :

a) d'une part, les paragraphes (8) et (9) n'exigent pas que le puits soit pourvu d'un tubage au-dessus de la surface du sol;

b) d'autre part, la fosse est pourvue d'un tubage allant du fond de la fosse jusqu'à au moins 40 centimètres au-dessus du point le plus élevé sur la surface du sol dans un rayon de trois mètres de l'extérieur du tubage de la fosse, après que le drainage superficiel est devenu conforme aux exigences de l'article 12.3, ainsi qu'il est mesuré au moment de l'achèvement de la fosse. Règl. de l'Ont. 389/09, art. 1.

(15) **Disposition abrogée avant l'ajout de la version française du règlement. Règl. de l'Ont. 372/07, par. 13 (8).**

(16) Les caractéristiques minimales du tubage sont les suivantes :

1. Les caractéristiques du tubage des puits à fort débit figurant au tableau 2 de la norme AWWA A100-06, dans ses versions successives.

2. Le tubage permanent externe des constructions de tubage à double paroi doit être fait de tuyaux d'acier qui sont conformes à la norme ASTM A252 ou à la norme ASTM A500.

3. Le tubage en acier dont le diamètre interne fait plus de 50,8 millimètres doit avoir une épaisseur nominale de paroi de 4,78 millimètres et une épaisseur minimale de paroi de 4,18 millimètres et être conforme à la norme ASTM A-53, catégorie B, à la norme ASTM A589, catégorie B, ou à la norme ASTM A500, catégorie B ou C.

4. Le tubage en acier dont le diamètre interne fait au plus 50,8 millimètres doit avoir une épaisseur nominale de paroi de 2,77 millimètres et une épaisseur minimale de paroi de 2,41 millimètres et être conforme à la norme ASTM A-53, catégorie B, à la norme ASTM A589, catégorie B, ou à la norme ASTM A500, catégorie B ou C.

5. Le tubage en acier galvanisé qui est ondulé et qui est utilisé dans les puits forés à la tarière ou creusés doit être de calibre 18 et être conforme à la norme ASTM A-53, catégorie B, à la norme ASTM A589, catégorie B, ou à la norme ASTM A500, catégorie B ou C.
6. Le tubage en béton dont le diamètre interne fait au moins 60,96 centimètres doit avoir une épaisseur nominale de paroi de 5,08 centimètres.
7. Le tubage en plastique dont le diamètre interne fait au moins 10,16 centimètres doit avoir une épaisseur minimale de paroi de 0,635 centimètres et être fait de tuyaux ABS ou PVC approuvés pour usage avec l'eau potable par l'Association canadienne de normalisation, la Canadian Society for Testing and Materials, l'ASTM ou la NSF International.
8. Le tubage en plastique renforcé doit être fabriqué à partir de résine vierge et de fibres vierges et être approuvé pour usage avec l'eau potable par la NSF International. Règl. de l'Ont. 389/09, art. 1.

(17) Le paragraphe (16) ne s'applique ni aux trous d'essai ni aux puits d'exhaure. Règl. de l'Ont. 389/09, art. 1.

(18) Le tubage utilisé dans un puits est un tubage continu. Règl. de l'Ont. 389/09, art. 1.

(19) La pose de joints dans un tubage est interdite, sauf s'il s'agit de joints qui :

a) d'une part, créent une liaison étanche permanente, tels que les joints en acier soudés;

b) d'autre part, sont faits de telle sorte que le tubage articulé ne dégrade pas la qualité de l'eau avec laquelle il entre en contact. Règl. de l'Ont. 389/09, art. 1.

(20) L'espace annulaire entre des tubages de diamètres différents est obturé au moyen d'un matériau d'étanchéité approprié de manière à empêcher la pénétration, dans le puits, des eaux de surface et d'autres matières étrangères. Règl. de l'Ont. 389/09, art. 1.

(21) Nul ne doit mettre à la terre un paratonnerre en l'attachant, directement ou indirectement, au tubage d'un puits. Règl. de l'Ont. 389/09, art. 1.

APPROFONDISSEMENT DES PUITS

13.1 (1) Si un puits est approfondi, l'article 13 s'applique, avec les adaptations nécessaires, comme si on construisait un nouveau puits. Toutefois, il est permis de continuer à utiliser le tubage du puits existant s'il paraît en bon état. Règl. de l'Ont. 389/09, art. 1.

(2) Nul ne doit construire un puits en pénétrant par forage ou par lançage ou fonçage le fond d'un puits foré à la tarière ou d'un puits creusé. Règl. de l'Ont. 389/09, art. 1.

ESPACE ANNULAIRE — MOUVEMENT SOUTERRAIN

14. Le constructeur d'un nouveau puits construit par quelque méthode que ce soit veille à ce que l'espace annulaire, autre que celui entourant le filtre du puits, soit obturé afin d'empêcher tout mouvement d'eau, de gaz naturel, de contaminants ou d'autres matières entre les formations souterraines ou entre une formation souterraine et la surface du sol par le biais de l'espace annulaire. Règl. de l'Ont. 389/09, art. 1.

ESPACE ANNULAIRE — CONSTRUCTION ET OBTURATION DE PUITS CONSTRUITS PAR FONÇAGE

14.1 (1) Le constructeur d'un nouveau puits construit par fonçage se conforme à l'article 14 en veillant à ce que l'espace annulaire soit rempli jusqu'à la surface du sol en recourant à un matériau et à une méthode qui sont approuvés par écrit par le directeur et qui, de l'avis de celui-ci, garantiront que le matériau placé dans l'espace annulaire ne comporte ni trous ni poches d'air. Règl. de l'Ont. 389/09, art. 1.

(2) Le paragraphe (1) ne s'applique ni au trou d'essai ni au puits d'exhaure dont l'abandon est prévu au plus tard 180 jours après l'achèvement des travaux de construction du trou ou du puits. Règl. de l'Ont. 389/09, art. 1.

ESPACE ANNULAIRE — CONSTRUCTION ET OBTURATION DE PUITS FORÉS À LA TARIÈRE POURVUS D'UN TUBAGE EN BÉTON

14.2 (1) Le constructeur d'un nouveau puits construit par forage à la tarière pour lequel un tubage en béton est utilisé veille à ce que le diamètre du puits :

a) depuis la surface du sol jusqu'à une profondeur de 2,5 mètres, dépasse d'au moins 15,2 centimètres le diamètre externe du tubage devant être utilisé;

b) depuis une profondeur de 2,5 mètres jusqu'à une profondeur d'au moins la pleine profondeur du puits ou jusqu'à six mètres, si cette profondeur est moindre, dépasse d'au moins 7,6 centimètres le diamètre externe du tubage devant être utilisé. Règl. de l'Ont. 389/09, art. 1.

(2) Le constructeur d'un nouveau puits construit par forage à la tarière pour lequel un tubage en béton est utilisé se conforme à l'article 14 en veillant à ce que les règles suivantes soient respectées :

1. Si un filtre de puits est installé :
   i. l'espace annulaire est rempli, depuis le fond du puits jusqu'à au moins le sommet du filtre, de gravier ou de sable lavé et propre qui est déposé après la pose du filtre et du tubage,
   ii. la partie restante de l'espace annulaire est remplie d'un matériau d'étanchéité approprié en direction ascendante depuis le sommet du gravier ou du sable visé à la sous-disposition i jusqu'au fond du matériau en bentonite visé à la disposition 6.
2. Le sommet du gravier ou du sable visé à la sous-disposition 1 i ne doit pas être situé à moins de six mètres de la surface du sol, sauf si un puits moins profond s'impose, vu la seule formation aquifère utilisable, auquel cas il ne doit pas être situé à moins de 2,5 mètres de la surface du sol.
3. Si aucun filtre de puits n'est installé, l'espace annulaire est rempli d'un matériau d'étanchéité approprié en direction ascendante depuis le fond du tubage jusqu'au fond du matériau en bentonite visé à la disposition 6.
4. Le matériau d'étanchéité visé à la sous-disposition 1 ii ou à la disposition 3 est déposé en continu en le chassant dans un tuyau à trémie dont la partie inférieure est immergée dans l'accumulation croissante de matériau d'étanchéité.

5. Si le matériau d’étanchéité visé à la sous-disposition 1 ii ou à la disposition 3 contient du ciment :
   i. d’une part, il faut le laisser durcir selon les spécifications du fabricant ou pendant 12 heures, selon le délai le plus long,
   ii. d’autre part, s’il s’est fixé ou si son volume a diminué après qu’il a durci conformément à la sous-disposition i, il est ramené au niveau initial.
6. Depuis la surface du sol jusqu’à une profondeur d’au moins 2,5 mètres, l’espace annulaire est rempli d’une couche de copeaux, de pastilles ou de granules de bentonite qui ont été filtrés selon les spécifications du fabricant et dont le diamètre fait de six à 20 millimètres. Règl. de l’Ont. 389/09, art. 1.

(3) Les paragraphes (1) et (2) ne s’appliquent ni au trou d’essai ni au puits d’exhaure dont l’abandon est prévu au plus tard 180 jours après l’achèvement des travaux de construction du trou ou du puits. Règl. de l’Ont. 389/09, art. 1.

ESPACE ANNULAIRE — CONSTRUCTION ET OBTURATION DE PUITS CREUSÉS

14.3 (1) Le constructeur d’un nouveau puits construit par creusage se conforme à l’article 14 en veillant à ce que l’espace annulaire soit rempli jusqu’à la surface du sol selon les règles suivantes :

1. L’espace annulaire, depuis le fond du puits et jusqu’à une profondeur d’au plus 2,5 mètres de la surface du sol, est rempli :
   i. soit de gravier ou de sable lavé et propre,
   ii. soit de matériaux originaux qui ont été excavés du trou, si le puits n’est pas construit dans une zone contaminée et que les horizons majeurs du sol ont été excavés et entreposés séparément, tenus à l’abri de la contamination et remblayés dans les mêmes positions relatives qu’ils occupaient au départ.
2. La partie restante de l’espace annulaire est remplie d’un matériau d’étanchéité approprié qui assure une résistance structurale suffisante pour supporter le poids des personnes et des véhicules susceptibles d’y circuler une fois la zone remplie. Règl. de l’Ont. 389/09, art. 1.

(2) Le paragraphe (1) ne s’applique ni au trou d’essai ni au puits d’exhaure dont l’abandon est prévu au plus tard 180 jours après l’achèvement des travaux de construction du trou ou du puits. Règl. de l’Ont. 389/09, art. 1.

ESPACE ANNULAIRE — CONSTRUCTION ET OBTURATION DE PUITS FORÉS À LA SONDEUSE ET D’AUTRES PUITS

14.4 (1) Le constructeur d’un nouveau puits construit autrement que par une méthode visée à l’article 14.1, 14.2 ou 14.3 ou par lançage veille à ce que le diamètre du puits, depuis la surface du sol jusqu’à une profondeur d’au moins la pleine profondeur du puits ou jusqu’à six mètres, si cette profondeur est moindre, dépasse d’au moins 7,6 centimètres le diamètre externe du tubage devant être utilisé. Règl. de l’Ont. 389/09, art. 1.

(2) Le constructeur d’un nouveau puits construit autrement que par une méthode visée à l’article 14.1, 14.2 ou 14.3 ou par lançage se conforme à l’article 14 en veillant à ce que les règles suivantes soient respectées :

1. Si un filtre de puits est installé :

    i. l’espace annulaire est rempli, depuis le fond du puits jusqu’à au moins le sommet du filtre, de gravier ou de sable lavé et propre qui, selon le cas :

        A. est déposé pendant ou après la pose du filtre et du tubage,

        B. se développe, après la pose du matériau d’étanchéité visé à la sous-disposition ii, par la pénétration d’eau à travers le filtre afin d’enlever les sols à grains fins adjacents,

    ii. la partie restante de l’espace annulaire est remplie d’un matériau d’étanchéité approprié en direction ascendante depuis le sommet du gravier ou du sable visé à la sous-disposition i jusqu’à la surface du sol.

2. Si aucun filtre de puits n’est installé, l’espace annulaire est rempli d’un matériau d’étanchéité approprié en direction ascendante depuis le fond du tubage jusqu’à la surface du sol.

3. Le sommet du gravier ou du sable visé à la disposition 1 ne doit pas être situé à moins de six mètres de la surface du sol, sauf si un puits moins profond s’impose, vu la seule formation aquifère utilisable, auquel cas il ne doit pas être situé à moins de 2,5 mètres de la surface du sol.

4. Le matériau d’étanchéité visé aux dispositions 1 et 2 est déposé en continu en le chassant dans un tuyau à trémie dont la partie inférieure est immergée dans l’accumulation croissante de matériau d’étanchéité.

5. Si le matériau d’étanchéité visé aux dispositions 1 et 2 contient du ciment :

    i. d’une part, il faut le laisser durcir selon les spécifications du fabricant ou pendant 12 heures, selon le délai le plus long,

    ii. d’autre part, s’il s’est fixé ou si son volume a diminué après qu’il a durci conformément à la sous-disposition i, il est ramené au niveau initial. Règl. de l’Ont. 389/09, art. 1.

(3) Le paragraphe (1) ne s’applique pas à un puits si les conditions suivantes sont réunies :

a) le puits est construit suivant un diamètre qui, depuis la surface du sol jusqu’à une profondeur d’au moins la pleine profondeur du puits ou jusqu’à six mètres, si cette profondeur est moindre, dépasse d’au moins 5,1 centimètres le diamètre externe du tubage devant être utilisé;

b) la taille maximale des particules du matériau d’étanchéité approprié qui est utilisé aux fins de conformité au paragraphe (2) ne conduit pas à la formation de ponts;

c) l’alignement approprié est assuré :

(i) dans le cas d'un puits construit à l'aide d'une foreuse à câble, au moyen d'un dispositif de centrage du tubage qui ne dégrade pas la qualité de l'eau avec laquelle il entre en contact et qui est placé deux mètres au-dessus du fond du tubage,

(ii) dans le cas d'un puits construit à l'aide d'une foreuse rotative, par l'utilisation de centralisateurs situés à une profondeur inférieure à six mètres. Règl. de l'Ont. 389/09, art. 1.

(4) Les paragraphes (1) à (3) ne s'appliquent ni au trou d'essai ni au puits d'exhaure dont l'abandon est prévu au plus tard 180 jours après l'achèvement des travaux de construction du trou ou du puits. Règl. de l'Ont. 389/09, art. 1.

ESPACE ANNULAIRE — PUITS POURVUS D'UNE FOSSE DE VISITE

14.5 (1) Le constructeur d'un nouveau puits construit par quelque méthode que ce soit qui comporte une fosse de visite veille :

a) d'une part, à ce que la fosse soit construite suivant un diamètre qui, depuis le fond de la fosse jusqu'à la surface du sol, dépasse d'au moins 7,6 centimètres le diamètre externe de la fosse;

b) d'autre part, à ce que l'espace annulaire situé à l'extérieur du tubage du puits soit rempli, depuis le fond de la fosse jusqu'à la surface du sol, d'un matériau d'étanchéité approprié qui assure une résistance structurale suffisante pour supporter le poids des personnes et des véhicules susceptibles d'y circuler une fois la zone remplie. Règl. de l'Ont. 389/09, art. 1.

(2) Si le matériau d'étanchéité visé à l'alinéa (1) b) contient du ciment :

a) d'une part, il faut le laisser durcir selon les spécifications du fabricant ou pendant 12 heures, selon le délai le plus long,

b) d'autre part, s'il s'est fixé ou si son volume a diminué après qu'il a durci conformément à l'alinéa a), il est ramené au niveau initial. Règl. de l'Ont. 389/09, art. 1.

(3) Les paragraphes (1) et (2) ne s'appliquent ni au trou d'essai ni au puits d'exhaure dont l'abandon est prévu au plus tard 180 jours après l'achèvement des travaux de construction du trou ou du puits. Règl. de l'Ont. 389/09, art. 1.

ESPACE ANNULAIRE — PUITS POURVUS D'UN TUBAGE À DOUBLE PAROI

14.6 Les articles 14 à 14.5 ne s'appliquent pas à un puits pourvu d'un tubage à double paroi, c'est-à-dire construit de façon à ce que le tubage soit entouré d'un tubage permanent d'un plus grand diamètre. Toutefois :

a) les articles 14, 14.2, 14.3, 14.4 et 14.5 s'appliquent, avec les adaptations nécessaires, à l'espace annulaire situé à l'extérieur du tubage externe;

b) les articles 14.2, 14.3 et 14.4 s'appliquent, avec les adaptations nécessaires, à l'espace annulaire situé entre les tubages, sauf s'il n'y a pas de fuites d'eaux souterraines dans cet espace. Règl. de l'Ont. 389/09, art. 1.

PUITS JAILLISSANTS

14.7 (1) Le constructeur d'un puits qui devient un puits jaillissant pendant sa construction fait ce qui suit :

a) il construit le puits de façon qu'il puisse non seulement recevoir un dispositif approprié qui limite l'écoulement de l'eau provenant de l'intérieur du tubage, qui est capable d'arrêter cet écoulement et qui est capable de résister au gel de l'eau dans le tubage, mais encore être compatible avec ce dispositif;

b) il installe le dispositif visé à l'alinéa a);

c) il construit le puits et installe le dispositif visé à l'alinéa a) de manière à empêcher tout écoulement incontrôlé d'eau du puits ou sur l'emplacement du puits;

d) il construit le puits et installe le dispositif visé à l'alinéa a) de manière à empêcher un refoulement d'eau dans le puits ou son tubage. Règl. de l'Ont. 389/09, art. 1.

(2) Le paragraphe (1) ne s'applique pas si le puits est abandonné conformément à l'article 21.1. Règl. de l'Ont. 389/09, art. 1.

(3) Chaque contrat de construction de puits est réputé comporter une clause qui impute à l'entrepreneur en construction de puits la responsabilité des frais suivants :

a) les frais afférents à l'observation du paragraphe (1);

b) si le paragraphe (1) ne s'applique pas par l'effet du paragraphe (2), les frais afférents à l'abandon du puits. Règl. de l'Ont. 389/09, art. 1.

(4) Le paragraphe (3) ne s'applique pas au contrat écrit qui dégage expressément l'entrepreneur en construction de puits de la responsabilité prévue à ce paragraphe. Règl. de l'Ont. 389/09, art. 1.

DÉVELOPPEMENT DU PUITS

14.8 (1) Avant l'achèvement des travaux de construction d'un nouveau puits, le constructeur prend toutes les mesures raisonnables pour en enlever les débris, notamment les sciures et les fluides de forage, en le développant jusqu'à ce que l'eau du puits soit claire et exempte de sable. Règl. de l'Ont. 389/09, art. 1.

(2) Le paragraphe (1) ne s'applique ni aux trous d'essai ni aux puits d'exhaure. Règl. de l'Ont. 389/09, art. 1.

DÉBIT DU PUITS

14.9 (1) Avant l'achèvement des travaux de construction d'un puits, le constructeur en vérifie le débit conformément à l'article 14.10. Règl. de l'Ont. 389/09, art. 1.

(2) Le paragraphe (1) ne s'applique pas à une modification mineure apportée à un puits ni à l'installation d'une pompe. Règl. de l'Ont. 389/09, art. 1.

(3) Le paragraphe (1) ne s'applique pas à un trou d'essai ou à un puits d'exhaure si le constructeur :

a) d’une part, mesure le niveau hydrostatique dans le puits au moyen d’un ruban en plastique ou en métal, d’une ligne d’air ou d’un dispositif électrique;

b) d’autre part, s’assure de la propreté de toute partie du ruban, de la ligne d’air ou du dispositif électrique qui entre en contact avec l’eau du puits. Règl. de l’Ont. 389/09, art. 1.

(4) Le paragraphe (1) ne s’applique pas à une modification apportée à un puits qui ne concerne que ce qui suit :

a) l’enlèvement du tubage au-dessus de la surface du sol de sorte qu’il affleure celle-ci;

b) l’installation d’un tubage au-dessus de la surface du sol;

c) la création ou l’enlèvement d’une fosse de visite. Règl. de l’Ont. 389/09, art. 1.

14.10 (1) Si le débit d’eau d’un puits fait l’objet d’une vérification, les règles suivantes sont observées :

a) le niveau d’eau du puits est mesuré et consigné dans le registre de puits :

(i) immédiatement avant le début du pompage,

(ii) à des intervalles d’une minute ou plus fréquemment au cours des cinq premières minutes de pompage,

(iii) à des intervalles de cinq minutes ou plus fréquemment au cours des 25 minutes suivantes de pompage,

(iv) à des intervalles de 10 minutes ou plus fréquemment au cours des 30 minutes suivantes de pompage,

(v) à des intervalles d’une minute ou plus fréquemment au cours des cinq premières minutes après l’arrêt du pompage,

(vi) à des intervalles de cinq minutes ou plus fréquemment au cours des 25 minutes suivantes après l’arrêt du pompage,

(vii) à des intervalles de 10 minutes ou plus fréquemment au cours des 30 minutes suivantes après l’arrêt du pompage;

b) le niveau d’eau du puits est mesuré au moyen d’un ruban en plastique ou en métal, d’une ligne d’air ou d’un dispositif électrique propre;

c) l’eau est pompée hors du puits à un débit uniforme et en continu pendant au moins une heure;

d) le débit de pompage pendant la vérification est consigné dans le registre de puits. Règl. de l’Ont. 389/09, art. 1.

(2) Les alinéas (1) a) et b) ne s’appliquent pas si la conception du puits ne permet pas de mesurer le niveau d’eau du puits pendant la vérification du débit. Règl. de l’Ont. 389/09, art. 1.

(3) Si l’eau ne peut pas être pompée hors du puits en continu pendant une heure conformément à l’alinéa (1) c), aucune autre mesure n’est requise en application de l’alinéa (1) a) et les renseignements suivants sont consignés dans le registre de puits :

a) la raison pour laquelle le pompage a été interrompu;

b) le débit de pompage et sa durée;

c) les mesures du niveau d'eau qui ont été obtenues. Règl. de l'Ont. 389/09, art. 1.

PLAQUE D'IDENTIFICATION DE PUITS

14.11 (1) Avant l'achèvement des travaux de construction d'un nouveau puits tubé, le constructeur obtient une plaque d'identification de puits du ministère et la fixe de façon permanente à l'extérieur du tubage ou de la structure permanente associée au puits, à un point où elle sera visible et ne sera pas obstruée par le bouchon ou d'autres éléments du puits ou par le matériel qui lui est associé. Règl. de l'Ont. 389/09, art. 1.

(2) Si une modification, autre qu'une modification mineure, est apportée à un puits tubé qui n'est pas déjà pourvu d'une plaque d'identification de puits, la personne qui apporte la modification obtient une plaque d'identification du ministère et, avant que les travaux de modification ne soient achevés, la fixe de façon permanente à l'extérieur du tubage ou de la structure permanente associée au puits, à un point où elle sera visible et ne sera pas obstruée par le bouchon ou d'autres éléments du puits ou par le matériel qui lui est associé. Règl. de l'Ont. 389/09, art. 1.

(3) Si une modification est apportée à un puits tubé qui est déjà pourvu d'une plaque d'identification de puits, la personne qui apporte la modification préserve cette plaque pendant les travaux de modification et si la plaque est enlevée, la personne, avant que les travaux ne soient achevés, la fixe de nouveau de façon permanente à l'extérieur du tubage ou de la structure permanente associée au puits, à un point où elle sera visible et ne sera pas obstruée par le bouchon ou d'autres éléments du puits ou par le matériel qui lui est associé. Règl. de l'Ont. 389/09, art. 1.

(4) Malgré le paragraphe (3), si une modification est apportée à un puits tubé qui est déjà pourvu d'une plaque d'identification de puits et que celle-ci est rendue inutilisable, notamment du fait qu'elle est cassée, mutilée ou illisible, la personne qui apporte la modification fait ce qui suit :

a) elle enlève la plaque et la retourne au directeur dans le délai visé à l'alinéa c);

b) elle obtient une nouvelle plaque du ministère et, avant que les travaux de modification ne soient achevés, la fixe de façon permanente à l'extérieur du tubage ou de la structure permanente associée au puits, à un point où elle sera visible et ne sera pas obstruée par le bouchon ou d'autres éléments du puits ou par le matériel qui lui est associé;

c) dans les 30 jours suivant la fixation de la nouvelle plaque au tubage, elle dresse un registre de puits notant le remplacement de la plaque et en fait parvenir une copie au directeur. Règl. de l'Ont. 389/09, art. 1.

(5) Malgré les paragraphes (1) à (4), si un seul registre de puits est dressé pour un groupe de puits conformément à l'article 16.4, il n'est pas nécessaire de fixer une plaque d'identification de puits à un autre puits du groupe si une telle plaque est déjà fixée au puits le plus profond du groupe. Règl. de l'Ont. 389/09, art. 1.

DÉSINFECTION

15. (1) Le jour où les travaux de construction du puits sont achevés, le constructeur veille à ce qui suit :

a) tous les débris se trouvant dans le puits sont enlevés;

b) l'eau du puits est chlorée jusqu'à une concentration de 50 à 200 milligrammes de chlore libre par litre d'eau et est laissée au repos pendant au moins 12 heures;

c) l'eau du puits ne sert pas pour la consommation humaine tant que les mesures prévues aux paragraphes (2) à (7) n'ont pas été prises. Règl. de l'Ont. 389/09, art. 1.

(2) La personne qui entreprend la construction d'un puits servant ou entretenu pour servir à la fin pour laquelle il a été construit ou qui installe du matériel de pompage dans un puits veille à ce que, dès que possible après l'achèvement de la construction ou de l'installation, l'eau du puits soit chlorée jusqu'à une concentration de 50 à 200 milligrammes de chlore libre par litre d'eau. Règl. de l'Ont. 389/09, art. 1.

(3) Le paragraphe (2) ne s'applique pas au remplacement d'une pompe qui est installée au-dessus ou à proximité d'un puits ou dans une fosse de visite, à moins que le remplacement ne concerne l'enlèvement d'un couvercle ou d'un bouchon de puits exigé par le paragraphe 15.2 (6) ou (7). Règl. de l'Ont. 389/09, art. 1.

(4) La personne visée au paragraphe (2) veille à ce que, de 12 heures à 24 heures après qu'elle est chlorée, l'eau du puits soit vérifiée pour y déceler la présence de chlore résiduel libre. Règl. de l'Ont. 389/09, art. 1.

(5) Si une vérification effectuée en application du paragraphe (4) révèle que la concentration de chlore résiduel libre dans l'eau du puits est inférieure à 50 milligrammes ou supérieure à 200 milligrammes par litre d'eau, la personne visée au paragraphe (2) veille à ce que les mesures suivantes soient prises :

1. L'eau est pompée hors du puits jusqu'à ce que la concentration de chlore résiduel libre dans l'eau soit inférieure à 1 milligramme par litre d'eau.

2. L'eau du puits est chlorée jusqu'à une concentration d'au plus 200 milligrammes de chlore libre par litre d'eau.

3. De 12 heures à 24 heures après qu'elle est chlorée conformément à la disposition 2, l'eau du puits est vérifiée pour y déceler la présence de chlore résiduel libre.

4. Si une vérification effectuée en application de la disposition 3 révèle que la concentration de chlore résiduel libre dans l'eau du puits est inférieure à 50 milligrammes ou supérieure à 200 milligrammes par litre d'eau, les mesures visées aux dispositions 1 à 3 et à la présente disposition sont prises à nouveau. Règl. de l'Ont. 389/09, art. 1.

(6) La personne qui est tenue de veiller à ce que les mesures énoncées au paragraphe (5) soient prises veille à ce qui suit :

a) sous réserve de la disposition 4 du paragraphe (5), les mesures sont prises dans l'ordre dans lequel elles sont énoncées à ce paragraphe;

b) chaque mesure est prise dès qu’il est raisonnablement possible de le faire. Règl. de l’Ont. 389/09, art. 1.

(7) Si une vérification effectuée en application du paragraphe (4) ou de la disposition 3 du paragraphe (5) révèle que la concentration de chlore résiduel libre dans l’eau du puits est d’au moins 50 milligrammes mais d’au plus 200 milligrammes par litre d’eau, la personne visée au paragraphe (2) veille à ce que l’eau soit pompée hors du puits jusqu’à ce que la concentration de chlore résiduel libre dans l’eau soit inférieure à 1 milligramme par litre d’eau. Règl. de l’Ont. 389/09, art. 1.

(8) Nul ne doit, pendant la période située entre la chloration de l’eau d’un puits par la personne visée au paragraphe (2) et la vérification de l’eau pour y déceler la présence de chlore résiduel libre effectuée en application du présent article :

a) perturber le puits;

b) utiliser le puits à quelque fin que ce soit. Règl. de l’Ont. 389/09, art. 1.

(9) La personne à qui incombe la responsabilité de veiller à ce que l’eau du puits soit vérifiée pour y déceler la présence de chlore résiduel libre en application du présent article veille à ce que, avant que le puits ne soit utilisé comme source d’eau pour la consommation humaine, un relevé écrit des résultats de la vérification soit remis à l’acheteur du puits. Règl. de l’Ont. 389/09, art. 1.

(10) Les paragraphes (4) à (9) ne s’appliquent pas à une modification qui est apportée à un puits si tous les critères suivants sont remplis :

1. La modification concerne la réparation ou le remplacement urgent d’une pompe qui est tombée en panne subitement.
2. Aucun approvisionnement en eau n’est immédiatement disponible pour remplacer l’eau du puits.
3. L’acheteur du puits donne des instructions écrites à la personne qui entreprend la modification pour qu’elle mette fin au processus de désinfection après s’être conformée au paragraphe (2). Règl. de l’Ont. 389/09, art. 1.

(11) Si, conformément au paragraphe (10), les paragraphes (4) à (9) ne s’appliquent pas à la modification apportée à un puits :

a) d’une part, l’acheteur du puits veille à ce que, avant qu’elle ne soit utilisée à une fin quelconque, l’eau du puits soit pompée hors du puits jusqu’à ce qu’elle ne dégage plus d’odeur de chlore;

b) d’autre part, la personne qui entreprend la modification conserve pendant deux ans les instructions écrites visées à la disposition 3 du paragraphe (10). Règl. de l’Ont. 389/09, art. 1.

(12) Le présent article ne s’applique pas si le directeur approuve par écrit une autre méthode de désinfection et que la méthode approuvée est suivie. Règl. de l’Ont. 389/09, art. 1.

(13) Le présent article ne s’applique pas à une modification mineure apportée à un puits. Règl. de l’Ont. 389/09, art. 1.

(14) Le présent article ne s'applique ni aux trous d'essai, ni aux puits d'exhaure ni aux puits jaillissants. Règl. de l'Ont. 389/09, art. 1.

AÉRATION

15.1 (1) Le constructeur d'un nouveau puits construit par quelque méthode que ce soit veille à ce que le puits soit bien aéré vers l'atmosphère extérieure de façon à pouvoir disperser tous les gaz en toute sécurité. Règl. de l'Ont. 389/09, art. 1.

(2) Le paragraphe (1) ne s'applique pas, selon le cas :

a) à un trou d'essai;

b) à un puits dont le tubage sert à transporter l'eau à l'extérieur du puits. Règl. de l'Ont. 389/09, art. 1.

(3) Si une pompe est installée dans un puits foré à la sondeuse, le constructeur du puits veille à ce qui suit :

a) il est installé un évent dont le diamètre interne minimal :

(i) fait 0,3 centimètre, si le diamètre interne du tubage fait moins de 12,7 centimètres,

(ii) fait 1,2 centimètre, si le diamètre interne du tubage fait au moins 12,7 centimètres;

b) l'évent, selon le cas :

(i) est d'une longueur suffisante pour se prolonger au-dessus du couvercle de la fosse de visite, s'il y en a une,

(ii) atteint une hauteur d'au moins 40 centimètres au-dessus de la surface du sol, soit suffisamment pour empêcher la pénétration d'eaux de crue pouvant provenir de toute inondation prévue dans la région, s'il n'y a pas de fosse de visite;

c) l'extrémité ouverte de l'évent est protégée et munie d'un grillage qui empêche la pénétration de toute matière dans le puits. Règl. de l'Ont. 389/09, art. 1.

(4) Le paragraphe (3) ne s'applique pas aux trous d'essai ou puits d'exhaure non tubés. Règl. de l'Ont. 389/09, art. 1.

(5) Le paragraphe (3) ne s'applique pas aux puits suivants s'il ne risque pas de s'y trouver du gaz naturel ou un autre gaz :

1. Un puits pourvu d'une fosse de visite.
2. Un trou d'essai ou un puits d'exhaure visé au paragraphe 13 (11). Règl. de l'Ont. 389/09, art. 1.

INSTALLATION DU MATÉRIEL

15.2 (1) Tout constructeur d'un puits se conforme aux exigences du présent article. Règl. de l'Ont. 389/09, art. 1.

(2) Si un raccord au tubage d'un puits foré à la sondeuse est fait sous la surface du sol, il faut utiliser un joint d'étanchéité de puits ou un coulisseau de raccordement, et le raccord doit être rendu étanche. Règl. de l'Ont. 389/09, art. 1.

(3) Un chalumeau coupeur ne doit pas être utilisé pour ménager une ouverture dans la paroi du tubage afin d'y poser un coulisseau de raccordement. Règl. de l'Ont. 389/09, art. 1.

(4) Si un raccord au tubage d'un puits, autre qu'un puits foré à la sondeuse, est fait sous la surface du sol, le raccord est rendu étanche au moyen d'un matériau adhésif durable. Règl. de l'Ont. 389/09, art. 1.

(5) Si un raccord au tubage d'un puits est fait sous la surface du sol, l'excavation extérieure est remplie d'un matériau d'étanchéité approprié qui entoure le tubage selon un rayon d'au moins 20 centimètres et qui monte depuis le fond de l'excavation jusqu'à 20 centimètres de la surface du sol. Règl. de l'Ont. 389/09, art. 1.

(6) Le sommet du tubage d'un puits construit par creusage ou par forage à la tarière est recouvert d'un couvercle de puits solide et étanche qui empêche la pénétration, dans le puits, des eaux de surface et d'autres matières étrangères. Règl. de l'Ont. 389/09, art. 1.

(7) Sous réserve de la disposition 8 du paragraphe 12 (9), le sommet du tubage d'un puits qui n'est pas construit par creusage ou par forage à la tarière est obturé au moyen d'un bouchon de puits de fabrication commerciale et à l'épreuve de la vermine. Règl. de l'Ont. 389/09, art. 1.

(8) Les paragraphes (6) et (7) ne s'appliquent que si tous les critères suivants sont remplis :

1. Un plancher a été construit autour du tubage du puits ou à proximité.
2. Une pompe est installée au-dessus ou à proximité du puits.
3. Le sommet du tubage est protégé de manière à empêcher la pénétration de toute matière susceptible de dégrader la qualité de l'eau du puits.
4. Le tubage du puits se prolonge sur au moins 15 centimètres au-dessus du plancher visé à la disposition 1. Règl. de l'Ont. 389/09, art. 1.

15.3 La personne qui installe du matériel dans un puits veille à ce qu'il soit propre. Règl. de l'Ont. 389/09, art. 1.

Renseignements

16. (1) Lorsqu'un puits est construit et que la présence d'eau minéralisée y est constatée, le constructeur en avise immédiatement l'acheteur du puits et le propriétaire du bien-fonds où celui-ci est situé. Règl. de l'Ont. 389/09, art. 1.

(2) Le paragraphe (1) ne s'applique ni aux trous d'essai ni aux puits d'exhaure. Règl. de l'Ont. 389/09, art. 1.

(3) Lorsqu'un puits est construit et que la présence de gaz naturel y est constatée, le constructeur en avise immédiatement l'acheteur du puits, le propriétaire du bien-fonds où celui-ci est situé et le directeur. Règl. de l'Ont. 389/09, art. 1.

16.1 (1) Le jour où les travaux de construction d'un puits sont achevés, le constructeur est tenu, sauf directive contraire de l'acheteur du puits, de faire ce qui suit :

a) remettre à l'acheteur une copie d'une trousse d'information sur les puits obtenue du ministère;

b) fournir à l'acheteur un échantillon d'eau provenant du puits, d'au moins un litre, pour examen visuel;

c) mesurer la profondeur du puits en présence de l'acheteur. Règl. de l'Ont. 389/09, art. 1.

(2) Le paragraphe (1) ne s'applique ni aux trous d'essai ni aux puits d'exhaure. Règl. de l'Ont. 389/09, art. 1.

(3) Le paragraphe (1) ne s'applique pas à une modification mineure apportée à un puits. Règl. de l'Ont. 389/09, art. 1.

16.2 (1) Le jour où une pompe est remplacée dans un puits existant, le constructeur du puits est tenu, sauf directive contraire de l'acheteur du puits, de remettre à ce dernier une copie d'une trousse d'information sur les puits obtenue du ministère. Règl. de l'Ont. 389/09, art. 1.

(2) Le paragraphe (1) ne s'applique ni aux trous d'essai ni aux puits d'exhaure. Règl. de l'Ont. 389/09, art. 1.

REGISTRES — REGISTRE DE PUITS DISTINCT

16.3 (1) Une fois achevés les travaux de construction d'un puits, le constructeur fait ce qui suit :

a) il dresse, conformément aux instructions sur la formule, un registre de puits pour le puits;

b) il remet une copie du registre de puits à l'acheteur du puits et au propriétaire du bien-fonds où celui-ci est situé dans les 14 jours suivant la date d'achèvement des travaux;

c) il fait parvenir une copie du registre de puits au directeur dans les 30 jours suivant la date d'achèvement des travaux;

d) il conserve une copie du registre de puits pendant deux ans. Règl. de l'Ont. 389/09, art. 1.

(2) Le paragraphe (1) ne s'applique pas à une modification mineure apportée à un puits ni à l'installation d'une pompe. Règl. de l'Ont. 389/09, art. 1.

(3) Le paragraphe (1) ne s'applique ni au trou d'essai ni au puits d'exhaure qui est abandonné dans les 30 jours suivant la date d'achèvement des travaux de construction. Règl. de l'Ont. 389/09, art. 1.

REGISTRES — GROUPES DE PUITS

16.4 (1) Malgré l'alinéa 16.3 (1) a), le constructeur de puits peut dresser un seul registre de puits pour un groupe de puits au lieu d'un registre de puits distinct pour chaque puits individuel si les conditions suivantes sont réunies :

1. Chaque puits du groupe est un trou d'essai ou un puits d'exhaure.
2. Chaque puits du groupe est situé :

i. sur le même bien qu'un autre puits du groupe,

ii. sur un bien qui est adjacent à un autre bien sur lequel est situé un autre puits du groupe, ou qui y serait adjacent s'il n'y avait pas de route entre les deux biens,

iii. sur un bien qui n'est séparé d'un autre bien sur lequel est situé un autre puits du groupe que par un ou deux biens intermédiaires.

3. Les travaux de construction de chaque puits du groupe sont achevés ou, si les puits sont construits par étapes, les travaux de construction de chaque puits sont achevés à l'étape pertinente.

4. Chaque propriétaire d'un bien-fonds où est situé un puits du groupe de puits a consenti par écrit à l'utilisation d'un seul registre de puits pour le groupe et le registre atteste que tous les consentements requis ont été donnés. Règl. de l'Ont. 389/09, art. 1.

(2) Pour l'application de la sous-disposition 2 iii du paragraphe (1), les règles suivantes s'appliquent à la détermination du nombre de biens intermédiaires qui séparent deux biens sur lesquels des puits sont situés :

1. Le nombre de biens intermédiaires est déterminé le long d'une ligne droite qui réunit les deux puits.

2. Si la ligne droite visée à la disposition 1 traverse une route, celle-ci ne doit pas être comptée comme bien intermédiaire, sauf si l'un des puits ou les deux sont situés sur les limites de la route ou en-deçà de ces limites.

3. Si une partie de la ligne droite visée à la disposition 1 est située sur les limites de la route ou en-deçà de ces limites, le nombre de biens intermédiaires est déterminé, par rapport aux biens adjacents à cette partie de la route, du côté de la route qui a le moins de biens. Règl. de l'Ont. 389/09, art. 1.

(3) Le constructeur de puits qui dresse un seul registre de puits pour un groupe de puits en vertu du paragraphe (1) fait ce qui suit :

a) il précise dans le registre, de manière commode, concise et complète, lesquels des puits ont des caractéristiques communes comme le diamètre, la technique de construction, le tubage, la ventilation, les pompes et la méthode d'abandon;

b) il joint au registre une déclaration portant qu'il remettra promptement au directeur, sur demande, les renseignements additionnels dont il a la garde ou le contrôle concernant tout puits du groupe de puits qu'il a construit;

c) malgré l'alinéa 16.3 (1) b), il remet à l'acheteur du puits et à chaque propriétaire d'un bien-fonds où est situé un puits du groupe de puits une copie du registre pour le groupe de puits dans les 60 jours suivant le début des travaux de construction du premier puits ou, si les puits sont construits par étapes, dans les 60 jours suivant le début des travaux de construction du premier puits à l'étape pertinente des travaux;

d) malgré l'alinéa 16.3 (1) c), il fait parvenir au directeur une copie du registre pour le groupe de puits dans les 75 jours suivant le début des travaux de construction du premier puits ou, si les puits sont construits par étapes, dans les 75 jours suivant le début des travaux de

construction du premier puits à l’étape pertinente des travaux. Règl. de l’Ont. 389/09, art. 1.

(4) Si un seul registre de puits est dressé pour un groupe de puits en vertu du paragraphe (1) et qu’une modification, autre qu’une modification mineure, est apportée à un puits du groupe :

a) le présent article cesse de s’appliquer au puits;

b) la personne qui apporte la modification obtient une plaque d’identification de puits qu’elle fixe conformément au paragraphe 14.11 (2) et se conforme à l’article 16.3. Règl. de l’Ont. 389/09, art. 1.

(5) Le constructeur de puits qui dresse un nouveau registre de puits en vertu du paragraphe (4) fait ce qui suit :

a) malgré l’alinéa 16.3 (1) b), il remet à l’acheteur du puits et à chaque propriétaire d’un bien-fonds où est situé un puits du groupe de puits touché par les travaux de construction subséquents une copie du registre de puits dans les 60 jours suivant le début des travaux de construction subséquents ou, si ceux-ci s’effectuent par étapes, dans les 60 jours suivant le début de l’étape pertinente de ces travaux;

b) malgré l’alinéa 16.3 (1) c), il fait parvenir au directeur une copie du registre de puits dans les 75 jours suivant le début des travaux de construction subséquents ou, si ceux-ci s’effectuent par étapes, dans les 75 jours suivant le début de l’étape pertinente de ces travaux. Règl. de l’Ont. 389/09, art. 1.

Registres — Abandon de puits

16.5 (1) Une fois achevée la procédure d’abandon d’un puits, la personne qui l’abandonne fait ce qui suit :

a) elle dresse, conformément aux instructions sur la formule, un registre de puits pour le puits;

b) elle remet une copie du registre de puits au propriétaire du bien-fonds où est situé le puits :

(i) dans les 14 jours suivant la date où le matériel de construction de puits est enlevé des lieux,

(ii) dans les 60 jours suivant la date où le premier puits est abandonné, si le puits fait partie d’un groupe de puits;

c) elle fait parvenir une copie du registre de puits ainsi que toute plaque d’identification qui a été enlevée du puits, le cas échéant, au directeur :

(i) dans les 30 jours suivant la date où le matériel de construction de puits est enlevé des lieux,

(ii) dans les 75 jours suivant la date où le premier puits est abandonné, si le puits fait partie d’un groupe de puits. Règl. de l’Ont. 389/09, art. 1.

(2) Le paragraphe (1) ne s’applique ni au trou d’essai ni au puits d’exhaure qui est abandonné dans les 30 jours suivant la date d’achèvement des travaux de construction. Règl. de l’Ont. 389/09, art. 1.

17. à **19. Dispositions abrogées avant l'ajout de la version française du règlement. Règl. de l'Ont. 372/07, art. 18.**

ENTRETIEN DES PUITS

20. (1) Le propriétaire d'un puits entretient le puits en permanence après la date d'achèvement des travaux de construction du puits, de manière à empêcher la pénétration, dans celui-ci, des eaux de surface et d'autres matières étrangères. Règl. de l'Ont. 389/09, art. 1.

(2) Si le tubage d'un puits se prolonge au-dessus de la surface du sol, nul ne doit :

a) réduire la hauteur du tubage, si celui-ci atteint une hauteur de moins de 40 centimètres au-dessus de la surface du sol;

b) réduire la hauteur du tubage à moins de 40 centimètres au-dessus de la surface du sol, si le tubage atteint une hauteur de 40 centimètres ou plus au-dessus de la surface du sol. Règl. de l'Ont. 389/09, art. 1.

(3) Le paragraphe (2) ne s'applique ni au puits visé au paragraphe 13 (10) ni au trou d'essai ou au puits d'exhaure visé au paragraphe 13 (11). Règl. de l'Ont. 389/09, art. 1.

ABANDON

21. (1) Le constructeur d'un nouveau puits dont les travaux de construction sont interrompus avant leur achèvement abandonne immédiatement le puits. Règl. de l'Ont. 389/09, art. 1.

(2) L'acheteur d'un nouveau puits qui est tari abandonne immédiatement le puits à moins que le propriétaire du bien-fonds où celui-ci est situé ne consente par écrit à l'entretenir en vue d'un usage futur en tant que tel. Règl. de l'Ont. 389/09, art. 1.

(3) Le propriétaire d'un puits qui n'est pas utilisé en tant que tel ou qui n'est pas entretenu en vue d'un usage futur en tant que tel abandonne immédiatement le puits. Règl. de l'Ont. 389/09, art. 1.

(4) Le propriétaire d'un puits qui produit une eau minéralisée abandonne immédiatement le puits. Règl. de l'Ont. 389/09, art. 1.

(5) Si un puits produit une eau qui n'est pas potable, le propriétaire l'abandonne immédiatement à moins qu'il ne demande des conseils au médecin-hygiéniste local et qu'il ne prenne les mesures que celui-ci lui ordonne de prendre. Règl. de l'Ont. 389/09, art. 1.

(6) Si un puits contient du gaz naturel ou un autre gaz, le propriétaire l'abandonne immédiatement à moins que des mesures ne soient prises pour gérer le gaz de façon à prévenir tout danger éventuel. Règl. de l'Ont. 389/09, art. 1.

(7) Si un puits permet le mouvement de gaz naturel, de contaminants ou d'autres matières entre les formations souterraines ou entre une formation souterraine et la surface du sol et que ce mouvement risque de dégrader la qualité de l'eau, le propriétaire du puits l'abandonne immédiatement à moins que des mesures ne soient prises pour empêcher un tel mouvement en permanence. Règl. de l'Ont. 389/09, art. 1.

(8) Si un puits est construit en contravention avec une disposition du présent règlement portant sur l'emplacement des puits, sur les méthodes et les matériaux utilisés dans la construction des puits ou sur les normes de construction des puits, le propriétaire du puits prend immédiatement des mesures

pour rectifier la situation. En cas d’échec de telles mesures, il abandonne immédiatement le puits. Règl. de l’Ont. 389/09, art. 1.

(9) Le propriétaire du puits veille à ce que les mesures prises conformément aux paragraphes (5) à (7) exercent leur effet en permanence. Règl. de l’Ont. 389/09, art. 1.

(10) Les paragraphes (4) à (8) ne s’appliquent pas si le propriétaire du puits a obtenu le consentement écrit du directeur. Règl. de l’Ont. 389/09, art. 1.

(11) Les paragraphes (4) et (5) ne s’appliquent ni aux trous d’essai ni aux puits d’exhaure. Règl. de l’Ont. 389/09, art. 1.

(12) Les paragraphes (4) et (5) ne s’appliquent pas aux puits qui :

a) d’une part, servent ou sont conçus pour servir de source d’eau pour l’agriculture;

b) d’autre part, ne servent pas de source d’eau pour la consommation humaine. Règl. de l’Ont. 389/09, art. 1.

(13) La personne qui abandonne le puits retient les services du titulaire d’une licence d’entrepreneur en construction de puits et veille à ce que le contrat conclu entre eux exige le recours, pour l’abandon du puits, à un technicien en construction de puits titulaire d’une licence l’autorisant à construire le type de puits en question, sauf si, selon le cas :

a) la personne qui procède à l’abandon du puits est le propriétaire du bien-fonds ou un membre de son ménage;

b) la personne qui procède à l’abandon du puits travaille sans rémunération pour une autre personne sur un bien-fonds appartenant à cette autre personne ou à un membre de son ménage;

c) la personne qui procède à l’abandon du puits est titulaire d’une licence visée à la disposition 1 du paragraphe 5 (1);

d) le puits est un trou d’essai ou un puits d’exhaure et est abandonné par une méthode ne nécessitant pas l’utilisation de matériel mécanique et la personne qui procède à l’abandon du puits est :

(i) soit une personne titulaire d’une licence visée à la disposition 5 du paragraphe 5 (1),

(ii) soit une personne visée à la disposition 1, 2 ou 3 de l’article 1.0.3. Règl. de l’Ont. 389/09, art. 1.

21.1 (1) Si un puits est abandonné, la personne qui l’abandonne veille à ce que les mesures suivantes soient prises, dans l’ordre dans lequel elles sont énoncées au présent paragraphe, sauf indication contraire :

1. Si le puits est déjà pourvu d’une plaque d’identification de puits, celle-ci est enlevée et retournée au directeur dans les 30 jours.
2. Si le tubage ou le filtre du puits s’est effondré, des efforts raisonnables sont déployés pour l’enlever et tout le matériel ainsi que tous les débris se trouvant dans le puits sont enlevés.
3. Le puits, y compris tout espace annulaire, est obturé :

i. dans le cas de n’importe quel puits, par la mise en place d’une colonne continue d’une barrière d’abandon depuis le fond du puits jusqu’à environ deux mètres sous la surface du sol, pour empêcher tout mouvement d’eau, de gaz naturel, de contaminants ou d’autres matières entre les formations souterraines ou entre une formation souterraine et le sommet de la barrière,

ii. dans le cas d’un puits dont le diamètre fait plus de 65 centimètres, par la mise en place d’une colonne continue d’une barrière d’abandon en prenant les mesures prévues au paragraphe (5) jusqu’à ce que les matières placées dans le puits en application de ce paragraphe atteignent environ deux mètres sous la surface du sol.

4. S’il n’a pas été enlevé en application de la disposition 2, le tubage ou le filtre du puits est enlevé, s’il est raisonnablement possible de le faire, pendant que sont prises les mesures exigées par la disposition 3, la partie inférieure du tubage étant immergée dans l’accumulation croissante de la barrière d’abandon jusqu’à ce que le niveau requis soit atteint.

5. S’il n’a pas été enlevé en application de la disposition 2 ou 4, le tubage ou le filtre du puits est enlevé, s’il est raisonnablement possible de le faire, jusqu’à une profondeur minimale de deux mètres sous la surface du sol.

6. Si la barrière d’abandon mise en place en application de la disposition 3 contient du ciment, il faut le laisser durcir et en rajouter au besoin jusqu’à ce qu’il atteigne environ deux mètres sous la surface du sol.

7. Sauf si cela risque de déstabiliser ou d’endommager les constructions qui restent ou de les rendre dangereuses, les structures, fondations et dalles souterraines en béton sont enlevées, avant la prise des mesures exigées par la disposition 8, jusqu’à une profondeur minimale suffisante pour permettre la prise des mesures d’obturation prévues à cette disposition.

8. Le puits est obturé à la surface du sol de la façon suivante :

i. par la mise en place d’une couche de copeaux, de pastilles, de granules ou de poudres de bentonite d’une épaisseur verticale de 50 à 150 centimètres dans l’ouverture du puits selon les spécifications du fabricant,

ii. par le remplissage du reste de l’ouverture du puits, jusqu’à la surface du sol, au moyen d’une couverture de sol ou d’une autre matière plus semblable à celle qui est immédiatement adjacente à cette ouverture afin d’empêcher l’accès par inadvertance ou non autorisé au puits.

9. La zone perturbée est stabilisée afin de prévenir l’érosion. Règl. de l’Ont. 389/09, art. 1.

(2) Les dispositions 2, 4 et 5 du paragraphe (1) ne s’appliquent pas aux personnes qui abandonnent un puits par surforation du puits entier. Règl. de l’Ont. 389/09, art. 1.

(3) Les règles suivantes s’appliquent dans le cadre des sous-dispositions 3 i et ii du paragraphe (1) :

1. La barrière d’abandon doit être compatible avec la qualité de l’eau du puits.

2. La barrière d’abandon ne doit contenir aucune matière qui puisse nuire à son intégrité, notamment du sol ou des sciures de forage.
3. La barrière d’abandon doit être stable en présence de tout contaminant avec lequel le puits est en contact.
4. La barrière d’abandon d’un puits dont le diamètre fait au plus 6,5 centimètres et dont le tubage et le filtre ont été enlevés en application de la disposition 2 du paragraphe (1) ou sont en voie de l’être en application de la disposition 4 ou 5 de ce même paragraphe doit consister, selon le cas :
    i. en un coulis composé d’eau propre, de ciment Portland et d’au plus 5 pour cent en poids de bentonite sous forme solide,
    ii. en un coulis composé d’eau propre et d’au moins 20 pour cent en poids de bentonite sous forme solide, la barrière devant être mise en place à l’aide d’un tuyau à trémie dont la partie inférieure est immergée dans l’accumulation croissante de la barrière jusqu’à ce que le niveau requis soit atteint.
5. La disposition 4 s’applique également, avec les adaptations nécessaires, à un puits non tubé dont le diamètre fait au plus 6,5 centimètres.
6. La barrière d’abandon d’un puits dont le diamètre fait au plus 6,5 centimètres et dont le tubage et le filtre n’ont pas été enlevés en application de la disposition 2 du paragraphe (1) et ne sont pas en voie de l’être en application de la disposition 4 ou 5 de ce même paragraphe doit consister, selon le cas :
    i. en un coulis composé d’eau propre, de ciment Portland et d’au plus 5 pour cent en poids de bentonite sous forme solide,
    ii. en une couche de copeaux ou de pastilles de bentonite qui ont été filtrés et placés selon les spécifications du fabricant.
7. La barrière d’abandon d’un puits dont le diamètre fait plus de 6,5 centimètres doit consister, selon le cas :
    i. en un coulis composé d’eau propre et d’au moins 20 pour cent en poids de bentonite sous forme solide,
    ii. en un coulis composé d’eau propre, de ciment Portland et d’au plus 5 pour cent de bentonite,
    iii. en un coulis composé d’eau propre et de ciment Portland,
    iv. en un coulis composé d’eau propre, de ciment Portland et de sable propre,
    v. en un coulis composé de poids égaux de ciment Portland et de gravier propre, mélangés d’eau propre,
    vi. en un coulis composé d’eau propre, de ciment Portland ainsi que de sable et de gravier propres,
    vii. en une couche de copeaux ou de pastilles de bentonite qui ont été filtrés et placés selon les spécifications du fabricant,

viii. en tout autre matériau que le directeur approuve par écrit, s'il est d'avis que le rendement de ce matériau est équivalent à celui d'un des coulis visés aux sous-dispositions i à vi.

8. La barrière d'abandon mouillée d'un puits dont le diamètre fait plus de 6,5 centimètres est mise en place à l'aide d'un tuyau à trémie dont la partie inférieure est immergée dans l'accumulation croissante de la barrière jusqu'à ce que le niveau requis soit atteint. Règl. de l'Ont. 389/09, art. 1.

(4) La sous-disposition 3 i du paragraphe (1) et le paragraphe (3) n'ont pas pour effet d'empêcher la mise en place de sable ou de gravier lavé et propre dans le trou de forage, à proximité des zones ou fractures génératrices d'eau, afin de réduire au minimum la perte de matériau d'étanchéité. Règl. de l'Ont. 389/09, art. 1.

(5) Les mesures visées à la sous-disposition 3 ii du paragraphe (1) à l'égard d'un puits dont le diamètre fait plus de 65 centimètres sont les suivantes et sont prises dans l'ordre dans lequel elles sont énoncées au présent paragraphe :

1. Du sable ou du gravier roulé propre est déposé au fond du puits jusqu'à la partie supérieure de la zone productrice d'eau la plus profonde ou jusqu'à la partie supérieure du filtre de puits, si celui-ci est plus profond.

2. Une couche d'au moins 0,1 mètre de copeaux ou de pastilles de bentonite est déposée par-dessus le sable ou le gravier roulé.

3. Si le niveau d'eau peut être abaissé jusqu'à la partie supérieure de la couche de copeaux ou de pastilles de bentonite :

   i. il est abaissé jusqu'à cette partie supérieure,

   ii. un coulis de bentonite, d'au moins 0,3 mètre, composé d'eau propre et d'au moins 20 pour cent de bentonite sous forme solide et compatible avec la qualité de l'eau du puits est mis en place par-dessus les copeaux ou pastilles de bentonite,

   iii. du gravier, du sable, du limon ou de l'argile propre est jeté sur le coulis de bentonite de façon à remplir le reste du puits, tout en maintenant une épaisseur d'au moins 0,3 mètre de coulis de bentonite au-dessus de l'accumulation croissante de gravier, de sable, de limon ou d'argile.

4. Si le niveau d'eau ne peut pas être abaissé jusqu'à la partie supérieure de la couche de copeaux ou de pastilles de bentonite, le reste du puits est rempli jusqu'à environ deux mètres sous la surface du sol d'une barrière d'abandon, qui peut être entrecoupée de sable ou de gravier roulé propre qui est mis en place dans chaque zone productrice d'eau du puits. Règl. de l'Ont. 389/09, art. 1.

(6) La personne qui abandonne un puits dont le diamètre fait plus de 65 centimètres veille à ce que du matériel d'obturation soit choisi et mis en place pour l'application des dispositions 3 et 8 du paragraphe (1) de façon à assurer une résistance structurale suffisante pour supporter le poids des personnes et des véhicules susceptibles d'y circuler une fois la zone remplie. Règl. de l'Ont. 389/09, art. 1.

(7) Si le puits est un puits jaillissant, de la boue de forage de fabrication commerciale et ne dégradant pas la qualité de l'eau avec laquelle elle entre en contact peut être utilisée, lors de la prise des mesures exigées par le paragraphe (1), afin d'aider à forer ou à mettre en place une barrière d'abandon. Toutefois, cette boue ne peut pas être utilisée comme barrière d'abandon. Règl. de l'Ont. 389/09, art. 1.

(8) Les dispositions 2 à 9 du paragraphe (1) et les paragraphes (3) à (7) ne s'appliquent pas aux personnes qui abandonnent un puits en l'excavant en entier dans le cadre de travaux qui sont effectués à une autre fin. Règl. de l'Ont. 389/09, art. 1.

(9) Le présent article s'applique également, avec les adaptations nécessaires, à une fosse de visite et, à cette fin, toute mention d'un puits aux paragraphes (1) à (8) est réputée valoir mention d'une telle fosse. Règl. de l'Ont. 389/09, art. 1.

PROTECTION DE LA PLAQUE D'IDENTIFICATION DE PUITS

22. (1) Nul ne doit utiliser une plaque d'identification de puits obtenue du ministère si ce n'est conformément au présent règlement. Règl. de l'Ont. 389/09, art. 1.

(2) Nul ne doit enlever une plaque d'identification de puits qui a été fixée conformément au présent règlement si ce n'est, selon le cas :

a) conformément au paragraphe 14.11 (3) ou (4) ou à la disposition 1 du paragraphe 21.1 (1);

b) avec le consentement écrit du directeur. Règl. de l'Ont. 389/09, art. 1.

(3) Nul ne doit abîmer, modifier, dissimuler ou obstruer une plaque d'identification de puits qui a été fixée conformément au présent règlement. Règl. de l'Ont. 389/09, art. 1.

FORMULES 1 à 9 **Formules abrogées avant l'ajout de la version française du règlement. Règl. de l'Ont. 128/03, art. 25.**

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Contact Information

Spills Action Centre 1-800-268-6060

Water well Help Desk:

Tel: 1-888-396-9355
Fax: (416) 235-5960

Email: helpdesk@waterwellontario.ca

Ministry of the Environment - Regional Offices

This list may be found at http://www.ene.gov.on.ca; (click on 'Contact' and then click on 'Regional Offices')

Figure 1: Map of Ministry Region

Northern Region

Ministry of the Environment
Thunder Bay Regional Office

Suite 331
435 James St. S.
3rd Floor
Thunder Bay ON P7E 6S7

Toll free from area codes 705/807:
1-800-875-7772
Tel: (807) 475-1205
Fax: (807) 475-1754

Ministry of the Environment
Kenora Area Office

808 Robertson St.
P. O. Box 5150
Kenora ON P9N 3X9

Toll free from area code 807:
1-888-367-7622
Tel: (807) 468-2718
Fax: (807) 468-2735

Ministry of the Environment
North Bay Area Office

191 Booth Road
Unit 16 & 17
North Bay ON P1A 4K3
Suite 103

Toll free: 1-800-609-5553
Tel: (705) 497-6865
Fax: (705) 497-6866

Ministry of the Environment
Sault Ste Marie Area Office

289 Bay Street,
Sault Ste. Marie ON P6A 1W7

Tel: (705) 942-6354
Fax: (705) 942-6327

Ministry of the Environment
Sudbury District Office

Suite 1201
199 Larch St.
Sudbury ON P3E 5P9

Toll free from area codes 705/807:
1-800-890-8516
Tel: (705) 564-3237
Fax: (705) 564-4180

Ministry of the Environment
Thunder Bay District Office

Suite 331
435 James St. S.
Thunder Bay ON P7E 6E3

Toll free from area code 705/807:
1-800-875-7772
Tel: (807) 475-1315
Fax: (807) 473-3160

Ministry of the Environment
Timmins District Office

Ontario Govt. Complex
Hwy 101 East
P.O. Bag 3080
South Porcupine ON P0N 1H0

Toll free in area codes 705/807:
1-800-380-6615
Tel: (705) 235-1500
Fax: (705) 235-1520

Central Region

Ministry of the Environment
Central Region Office

5775 Yonge St.
8th floor
North York ON M2M 4J1

Toll free: 1-800-810-8048
Tel: (416) 326-6700
Fax: (416) 325-6345

MINISTRY OF THE ENVIRONMENT
HALTON-PEEL DISTRICT OFFICE

4145 North Service Road
Suite 300
Burlington ON L7L 6A3

Toll free: 1-800-335-5906
Tel: (905) 319-3847
Fax: (905) 319-9902

MINISTRY OF THE ENVIRONMENT
METRO TORONTO DISTRICT OFFICE

5775 Yonge St.
8th floor
North York ON M2M 4J1

Toll free: 1-800-810-8048
Tel: (416) 326-6700
Fax: (416) 325-6346

MINISTRY OF THE ENVIRONMENT
BARRIE DISTRICT OFFICE

54 Cedar Pointe Dr.
Unit 1203
Barrie ON L4N 5R7

Toll free: 1-800-890-8511
Tel: (705) 739-6441
Fax: (705) 739-6440

MINISTRY OF THE ENVIRONMENT
YORK-DURHAM DISTRICT OFFICE

230 Westney Rd. S., 5th floor
Ajax ON L1S 7J5

Toll free: 1-800-376-4547
Tel: (905) 427-5600
Fax: (905) 427-5602

EASTERN REGION

MINISTRY OF THE ENVIRONMENT
KINGSTON REGIONAL OFFICE

Box 22032
1259 Gardiners Road
Kingston ON K7M 8S5

Toll free for area codes 613/705/905:
1-800-267-0974
Tel: (613) 549-4000
Fax: (613) 548-6908

MINISTRY OF THE ENVIRONMENT
BELLEVILLE AREA OFFICE

345 College Street East
Belleville, ON K8N 5S7

Toll free from area code 613: 1-800-860-2763
Tel: (613) 962-9208
Fax: (613) 962-6809

MINISTRY OF THE ENVIRONMENT
CORNWALL AREA OFFICE

113 Amelia St.
Cornwall ON K6H 3P1

Toll free number for area code 613:
1-800-860-2760
Tel: (613) 933-7402
Fax: (613) 933-6402

MINISTRY OF THE ENVIRONMENT
KINGSTON DISTRICT OFFICE

Box 22032
1259 Gardiners Road
Kingston, ON K7M 8S5

Toll free for area codes 613/705/905:
1-800-267-0974
Tel: (613) 549-4000 extension 2692
Fax: (613) 548-6920

MINISTRY OF THE ENVIRONMENT
OTTAWA DISTRICT OFFICE

2430 Don Reid Drive
Ottawa ON K1H 1E1

Toll free: 1-800-860-2195
Tel: (613) 521-3450
Fax: (613) 521-5437

MINISTRY OF THE ENVIRONMENT
PETERBOROUGH DISTRICT OFFICE

300 Water Street, Robinson Place
Peterborough ON K9J 8M5

Toll free from area codes:
613/705/905:
1-800-558-0595
Tel: (705) 755-4300
Fax: (705) 755-4321

West-Central Region

Ministry of the Environment Hamilton Regional Office

12th floor
119 King St. W.
Hamilton ON L8P 4Y7

Toll free: 1-800-668-4557
Tel: (905) 521-7640
Fax: (905) 521-7820

Ministry of the Environment Guelph District Office

1 Stone Road W.
Guelph ON N1G 4Y2

Toll free: 1-800-265-8658
Tel: (519) 826-4255
Fax: (519) 826-4286

Ministry of the Environment Hamilton District Office

9th floor
119 King St. W.
Hamilton ON L8P 4Y7

Toll free: 1-800-668-4557
Tel: (905) 521-7650
Fax: (905) 521-7806

Ministry of the Environment Niagara District Office

9th floor
301 St. Paul St.
St. Catharines ON L2R 3M8

Toll free: 1-800-263-1035
Tel: (905) 704-3900
Fax: (905) 704-4015

Southwestern Region

Ministry of the Environment London Regional Office

2nd Floor.
659 Exeter Road
London ON N6E 1L3

Toll free number from area code 519:
1-800-265-7672
Tel: (519) 873-5000
Fax: (519) 873-5020

Ministry of the Environment Owen Sound Area Office

1580-20th St. E. P.O. 967
Owen Sound ON N4K 6H6

Toll free number from area code 519:
1-800-265-3783
Tel: (519) 371-2901
Fax: (519) 371-2905

Ministry of the Environment Sarnia District Office

1094 London Rd.
Sarnia ON N7S 1P1

Toll free number: 1-800-387-7784
Tel: (519) 336-4030
Fax: (519) 336-4280

Ministry of the Environment Windsor Area Office

4510 Roads Drive
Unit 620
Windsor ON N8W 5K5

Toll free number: 1-800-387-8826
Tel: (519) 948-1464
Fax: (519) 948-2396

PUBLIC HEALTH UNITS

This list can be found at the website:

http://www.health.gov.on.ca/english/public/contact/phu/phuloc_mn.html

ALGOMA PUBLIC HEALTH UNIT

Civic Centre, 6th Floor
99 Foster Drive
Sault Ste. Marie, ON P6A 5X6

Toll free number: 1-866-892-0172
Tel: (705) 759-5287
Fax: (705) 759-1534

BRANT COUNTY HEALTH UNIT

194 Terrace Hill Street
Brantford, ON N3R 1G7

Tel: (519) 753-4937
Fax: (519) 753-2140

CHATHAM-KENT HEALTH UNIT

P.O. Box 1136
435 Grand Avenue West
Chatham, ON N7M 5L8

Tel: (519) 352-7270
Fax: (519) 352-2166

CITY OF HAMILTON

1 Hughson Street North
Hamilton, ON L8R 3L5

Tel: (905) 546-3500
Fax: (905) 546-4075

Reporting Adverse Water Results:

Tel: (905) 546-2424 x7277

Reporting Adverse Water Results Fax:

(905) 546-2787

DURHAM REGION HEALTH DEPARTMENT

605 Rossland Road East
P.O. Box 730
Whitby, ON L1N 0B2

Toll free number: 1-800-841-2729
Tel: (905) 668-7711
Fax: (905) 666-6214

EASTERN ONTARIO HEALTH UNIT

1000 Pitt Street
Cornwall, ON K6J 5T1

Toll free number: 1-800-267-7120
Tel: (613) 933-1375
Fax : (613) 933-7930

ELGIN-ST. THOMAS HEALTH UNIT

99 Edward Street
St. Thomas, ON N5P 1Y8

Toll Free Number: 1-800-922-0096
Tel: (519) 631-9900
Fax: (519) 633-0468

GREY BRUCE HEALTH UNIT

101 17th Street East
Owen Sound, ON N4K 0A5

Toll free number: 1-800-263-3456
Tel: (519) 376-9420
Fax: (519) 376-0605

HALDIMAND-NORFOLK HEALTH UNIT

P. O. Box 247
12 Gilbertson Drive
Simcoe, ON N3Y 4L1

Tel: (519) 426-6170
Fax: (519) 426-9974

HALIBURTON, KAWARTHA, PINE RIDGE DISTRICT HEALTH UNIT

200 Rose Glen Road
Port Hope, ON L1A 3V6

Toll free number: 1-866-888-4577
Tel: (905) 885-9100
Fax: (905) 885-9551

HALTON REGION HEALTH DEPARTMENT

1151 Bronte Road
Oakville, Ontario
L6M 3Ll

Toll free number: 1-866-442-5866
Tel: (905) 825-6000
TTY: (905) 827-9833
Fax: (905) 825-8588

HASTINGS AND PRINCE EDWARD COUNTIES HEALTH UNIT

179 North Park Street
Belleville, ON K8P 4P1

Tel: (613) 966-5500
Fax: (613) 966-9418

HURON COUNTY HEALTH UNIT

Health and Library Complex
Highway 4 South
R.R. 5, P.O.Box 1120
Clinton, ON N0M 1L0

Tel: (519) 482-3416
Fax: (519) 482-7820

KINGSTON, FRONTENAC AND LENNOX & ADDINGTON PUBLIC HEALTH

221 Portsmouth Avenue
Kingston, ON K7M 1V5

Toll free number: 1-800-267-7875
Tel: (613) 549-1232
Fax: (613) 549-7896

LAMBTON HEALTH UNIT

Community Health Services Department
160 Exmouth Street
Point Edward, ON N7T 7Z6

Toll free number: 1-800-667-1839
Tel: (519) 383-8331
Fax: (519) 383-7092

LEEDS, GRENVILLE AND LANARK DISTRICT HEALTH UNIT

458 Laurier Boulevard
Brockville, ON K6V 7A3

Tel: (613) 345-5685
Fax: (613) 345-2879

MIDDLESEX-LONDON HEALTH UNIT

50 King Street
London, ON N6A 5L7

Tel: (519) 663-5317
Fax: (519) 663-9581

NIAGARA REGION PUBLIC HEALTH DEPARTMENT

2201 St. David's Road
Campbell East
Thorold, ON L2T 4C2

Toll free number: 1-800-263-7248
Tel: (905) 688-3762
Fax: (905) 682-3901

NORTH BAY PARRY SOUND DISTRICT HEALTH UNIT

681 Commercial Street
North Bay, ON P1B 4E7

Tel: (705) 474-1400
Fax: (705) 474-8252

NORTHWESTERN HEALTH UNIT

21 Wolsley Street
Kenora, ON P9N 3W7

Toll free number: 1-800-830-5978
Tel: 807-468-3147
Fax: 807-468-4970

OTTAWA PUBLIC HEALTH

100 Constellation Cres.
Ottawa, ON K2G 6J8

Toll free number: 1-866-426-8885
Tel: (613) 580-6744
TTY: (613) 580-9656
Fax: (613) 580-9601

OXFORD COUNTY - PUBLIC HEALTH & EMERGENCY SERVICES

410 Buller Street
Woodstock, ON N4S 4N2

Toll free number: 1-800-755-0394
Tel: (519) 539-9800
Fax: (519) 539-6206

SIMCOE MUSKOKA DISTRICT HEALTH UNIT

15 Sperling Drive
Barrie, ON L4M 6K9

Toll free number: 1-877-721-7520
Tel: (705) 721-7520
Fax: (705) 721-1495

SUDBURY AND DISTRICT HEALTH UNIT

1300 Paris Street
Sudbury, ON P3E 3A3

Tel: (705) 522-9200
Fax: (705) 522-5182

THUNDER BAY DISTRICT HEALTH UNIT

999 Balmoral Street
Thunder Bay, ON P7B 6E7

Tel: 807-625-5900
Fax: 807-623-2369

Toll free number: 1-888-294-6630
(807 areas only)

TIMISKAMING HEALTH UNIT

P.O. Box 1240
221 Whitewood Avenue
New Liskeard, ON P0J 1P0

Tel: (705) 647-4305
Fax: (705) 647-5779

TORONTO PUBLIC HEALTH

277 Victoria Street, 5th Floor
Toronto, ON M5B 1W2

Tel: (416) 392-7401
Fax: (416) 392-0713

WELLINGTON-DUFFERIN-GUELPH PUBLIC HEALTH

474 Wellington Road #18, Suite 100
RR 1
Fergus, ON N0B 1J0

Tel: (519) 846-2715
Fax: (519) 846-0323

WINDSOR-ESSEX COUNTY HEALTH UNIT

1005 Ouellette Avenue
Windsor, ON N9A 4J8

Tel: (519) 258-2146
Fax: (519) 258-6003

Conservation Authorities

There is a number of conservation authorities located in each of Ontario's three regions. Main offices for each authority are listed with contact information on the following pages.

Figure 2: Conservation Authorities of Ontario

Southwestern Region

Figure 3: Conservation Authorities of Ontario – Southwestern Region

Grey Sauble Conservation Authority

#237897 Inglis Falls Road
R.R. #4, Owen Sound, ON
N4K 5N6

Phone: (519) 376-3076
Fax: (519) 371-0437

Email: admin@greysauble.on.ca

http://www.greysauble.on.ca/

Nottawasaga Conservation Authority

8195 8th Line
Utopia, ON
LOM 1TO

Phone: (705) 424-1479
Fax: (705) 424-2115

Email: admin@nvca.on.ca

www.nvca.on.ca

Saugeen Conservation Authority

R.R. # 1. Hanover, ON
N4N 3B8

Phone: (519) 364-1255
Fax: (519) 364-6990

Email: publicinfo@svca.on.ca

http://www.svca.on.ca/

Lake Simcoe Region Conservation Authority

120 Bayview Parkway
Box 282, Newmarket, ON
L3Y 4X1

Phone: (905) 895-1281
Fax: (905) 853-5881

http://www.lsrca.on.ca/

Toronto and Region Conservation Authority

5 Shoreham Drive
Downsview, ON
M3N 1S4

Phone: (416) 661-6600
Fax: (416) 661-6898

E-mail: info@trca.on.ca

Website: http://www.trca.on.ca/

Credit Valley Conservation authority

1255 Old Derry Road
Mississauga, ON
L5N 6R4

Phone: (905) 670-1615 or
1-800-668-5557
Fax: (905) 670-2210

Email: cvc@creditvalleycons.com

Website: www.creditvalleycons.com

GRAND RIVER CONSERVATION AUTHORITY

400 Clyde Road
PO Box 729
Cambridge, ON
N1R 5W6

Phone: (519) 621-2761 or
1-866-900-4722
Fax: (519) 621-4844

Email: grca@grandriver.ca

http://www.grandriver.ca/

MAITLAND VALLEY CONSERVATION AUTHORITY

1093 Marietta Street
Box 127
Wroxeter, ON N0G 2X0

Phone: (519) 335-3557
Fax: (519) 335-3516

Email: info@mvca.on.ca

http://www.mvca.on.ca/

Southeastern Region

Figure 4: Conservation Authorities - South-Eastern Region

Raison Region Conservation Authority

18045 County Road #2
P.O. Box 429 Cornwall, ON

R.R. #4, Owen Sound, ON
K6H 5T2

Phone: (613) 938-3611
Fax: (613) 938-3221

http://www.rrca.on.ca/

South Nation Conservation Authority

P.O. Box 429 Cornwall, ON

15 Union Street, Berwick, ON
K0C 1G0

Phone: Toll-free 1-877-984-2948;
613) 984-2948
Fax: (613) 984-2872

www.nation.on.ca

Rideau Valley Conservation Authority

P.O. Box 599
3889 Rideau Valley Drive, Manotick, ON
K4M 1A5

Phone: Toll-free 1-800-267-3504;
(613) 692-3571
Fax: (613) 692-0831

http://rvca.ca/index2.html

Mississippi Valley Conservation Authority

4175 Hwy 511, RR#2
Lanark, ON
K0G 1K0

Phone: (613)-259-2421
Fax: (613) 259-3468

Email: info@mvc.on.ca

http://www.mvc.on.ca/

Cataraqui Region Conservation Authority

P.O. Box 160, Glenburnie, ON
K0H 1S0

Phone: Toll-free 1-877-956-2722;
(613)-546-4228
Fax: (613) 547-6474

http://www.cataraquiregion.on.ca/

Quinte Conservation Authority

2061 Old Highway 2
R.R. #2, Belleville ON
K8N 4Z2

Phone: (613)-968-3434 or
(613)-354-3312
Fax: (613) 968-8240

www.quinteconservation.ca

Crowe Valley Conservation Authority

70 Hughes Lane
P.O. Box 416, Marmora ON
K0K 2M0

Phone: (613)-472-3137
Fax: (613) 472-5516

Email: info@crowevalley.com

http://www.crowevalley.com/

Lower Trent Conservation Authority

714 Murray Street
R.R. #1, Trenton, ON
K8V 5P4

Phone: (613) 394-3915
Fax: (613) 394-5226

http://www.ltc.on.ca/

Otonabee Conservation Authority

250 Milroy Drive
Peterborough, ON
K9H 7M0

Phone: (705) 745-5791
Fax: (705) 475-7488

http://www.otonabee.com/orca/

Ganaraska Conservation Authority

P.O. Box 328
2216 County Road 28, Port Hope, ON
L1A 3W4

Phone: (905) 885-8173
Fax: (905) 885-9824

http://www.grca.on.ca/

Central Lake Ontario Conservation Authority

100 Whiting Ave.
Oshawa, Ontario
L1H 3TC

Phone: (905) 579-0411
Fax: (905) 579-0994

Email: mail@cloca.com

http://www.cloca.com/

Kawartha Conservation Authority

277 Kenrei Road
Lindsay ON
K9V 4R1

Phone: (705) 328-0411
Fax: (705) 328-2286

Email:
geninfo@kawarthaconservation.com

http://www.kawarthaconservation.co
m/

NORTHERN REGION

FIGURE 5: CONSERVATION AUTHORITIES - NORTHERN REGION

LAKEHEAD REGION CONSERVATION AUTHORITY

P.O. Box 10427
130 Conservation Road
Thunder Bay, ON
P7B 6T8

Phone: (807) 344-5857
Fax: (807) 345-9156

Email: info@lakeheadca.com

http://www.lakeheadca.com/

SAULT STE. MARIE REGION CONSERVATION AUTHORITY

1100 Fifth Line East
Sault Ste. Marie, ON
P6A 5K7

Phone: (705) 946-8530
Fax: (705) 946-8533

E-mail: nature@ssmrca.ca

NICKEL DISTRICT CONSERVATION AUTHORITY

200 Brady Street, First Floor
Tom Davie Square
Sudbury, ON
P3E 5K3

Phone: (705) 674-5249
Fax: (705) 674-7939

E-mail: ndca@city.greatersudbury.on.ca

http://www.nickeldistrict.ca

NICKEL DISTRICT CONSERVATION AUTHORITY

200 Brady Street, First Floor
Tom Davie Square
Sudbury, ON
P3E 5K3

Phone: (705) 674-5249
Fax: (705) 674-7939

E-mail: ndca@city.greatersudbury.on.ca

http://www.nickeldistrict.ca

MATTAGAMI REGION CONSERVATION AUTHORITY

100 Lakeshore Road
Timmins, ON
P4N 8R5

Phone: (705) 360-2660
Fax: (705) 360-2692

http://www.timmins.ca/

NORTH BAY – MATTAWA CONSERVATION AUTHORITY

15 Janey Avenue
North Bay, ON
P1C 1N1

Phone: (705) 474-5420
Fax: (705) 474-9793

E-mail: nbmca@nbmca.on.ca

http://www.nbmca.on.ca/site/home.asp?id=12

INTERNET RESOURCES

PROVINCIAL RESOURCES

ASSOCIATION OF PROFESSIONAL GEOSCIENTISTS OF ONTARIO

http://www.apgo.net/

ENVIRONMENTAL COMMISSIONER OF ONTARIO'S RESOURCE LIBRARY

http://www.eco.on.ca/eng/index.php/environmental-bill-of-rights/role-of-the-eco/resource-centre-library.php

MINISTRY OF THE ENVIRONMENT WATER WELLS WEBSITE:

http://www.ene.gov.on.ca/envision/water/wells.htm

MINISTRY OF THE ENVIRONMENT WATER WELL ONTARIO WEBSITE: THIS WEBSITE HAS A DATABASE OF LICENCED WELL CONTRACTORS.

http://www.waterwellontario.ca/

ONTARIO ASSOCIATION OF CERTIFIED ENGINEERING TECHNICIANS AND TECHNOLOGISTS

http://www.oacett.org

ONTARIO MINISTRY OF AGRICULTURE, FOOD AND RURAL AFFAIRS PUBLICATIONS ONLINE:

Information on care and maintenance of private wells; including, what to do in times of water shortage, maintaining water quality, protecting drinking water and proper construction and abandonment of wells.

http://www.omafra.gov.on.ca/english/environment/water/publications.htm

ONTARIO GROUND WATER ASSOCIATION (OGWA):

"Created in 1952 as a not-for-profit organization to facilitate the various sectors of the groundwater industry coming together for the delivery of safe and clean water supplies throughout the Province."

http://www.ogwa.ca/

PROFESSIONAL ENGINEERS ONTARIO

http://www.peo.on.ca/

SERVICE ONTARIO E-LAWS:

http://www.e-laws.gov.on.ca

Canadian Resources

Alberta Department of Agriculture and Rural Development:

Water Wells that Last Generations Online Manuals for the construction, maintenance and abandonment of water wells.

http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/wwg404

Canadian Groundwater Association –

"national voice of the groundwater industry in Canada"; includes numerous fact sheets on groundwater and sanitizing a water well, etc."

http://www.cgwa.org/

Canadian Waste Water Agency (OCWA)

Provides wastewater treatment resources

http://www.cwwa.ca

Environment Canada:

Green Lane: Provides information about environmental preservation including the conservation and protection of Canada's water resource.

http://www.ec.gc.ca/

Fleming College:

For information about training courses for well technicians in Ontario:

http://www.welltechtraining.org

Ontario Clean Water Agency (OCWA):

provides wastewater treatment resources:

http://www.ocwa.com

Canadian Water Resources Association:

"Promoting Effective Water Management":

http://www.cwra.org/

Ontario Water Works Association (OWWA):

"A voluntary membership organization of drinking water professionals dedicated to protecting public health through the delivery of safe, sufficient and sustainable drinking water in Ontario."

http://www.owwa.com/hm/inside.php?id=15

Well Wise –

A "resource, research and education centre that provides support to private well owners across Ontario and professionals that work with them".

http://www.wellwise.ca/

International Resources

Most of the following sites are U.S. based water information sites and include general and global information on water resources and issues.

American Groundwater Trust –

Educational organization re the hydrologic, economic and environmental significance of groundwater; includes a 12-part groundwater education series

http://www.agwt.org/

Oregon State University –

Groundwater Stewardship – provides basics of understanding groundwater and its protection

http://www.groundwater.orst.edu/

National Sanitation Foundation

http://www.nsf.org/

U.S. National Groundwater Association

http://www.ngwa.org/

UK's Centre of Ecology and Hydrology

http://www.ceh.ac.uk/index.html

Water Magazine.com –

Water policy ideas and information from around the world

http://www.watermagazine.com/

U.S. Environmental Protection Agency –

Number of articles on groundwater, aquifers, wells, etc.; also general water articles such as water cycle; link to groundwater primer on basics, quality, what you can do, protection programs, glossary and references

http://www.epa.gov/seahome/

American Water Works Association

http://www.awwa.org/

Michigan Department of Environmental Quality

http://www.michigan.gov/deq/0,1607,7-135-3313_3675---,00.html

NSF Certified Product and Service Listings

http://www.nsf.org/business/search_listings/index.asp

CONVERSION TABLES

To Convert: On the left hand column of the table is the SI (Systeme International d'Unites). To convert from Metric units to Imperial units, simply multiply by the conversion factor in the upper portion of each cell. To convert from the Imperial units to Metric units, simply multiply by the conversion factor in the lower portion of each cell. The arrows next to each conversion factor show the direction of the conversion.

Table 2: Conversion Table for Length

mm	x 0.03937 →	inches
	← x 25.4	
mm	x 3.28×10^{-3} →	feet
	← x 304.8	
cm	x 0.3937 →	inches
	← x 2.54	
cm	x 0.0328 →	feet
	← x 30.48	
m	x 39.37 →	inches
	← x 0.0254	
m	x 3.281 →	feet
	← x 0.3048	
km	x 3 280.84 →	feet
	← x 0.3048×10^{-3}	
km	x 1 093.61 →	yards
	← x 9.144×10^{-4}	
km	x 0.6214 →	miles
	← x 1.609	

Table 1: Conversion Table for Area and Volume Measurements

m^2	x 10.7639 →	square feet
	← x 0.0929	
m^2	x 1.196 →	square yards
	← x 0.8361	
m^2	x 2.471×10^{-4} →	acres
	← x 4046.9	
ha	x 2.471 →	acres
	← x 0.40469	
cm^3	x 0.061024 →	cubic inches
	← x 16.387	
m^3	x 35.315 →	cubic feet
	← x 0.02832	
m^3	x 219.9 →	Imperial gallons
	← x 4.546×10^{-3}	
L	x 0.2199 →	Imperial gallons
	← x 4.546	
mL	x 0.000219 →	Imperial gallons
	← x $.434\,6 \times 10^{-5}$	
m^3	x $.2199 \times 10^{-3}$ →	Million Imp. gallons
	← x 4.546×10^{3}	

Table 3: Conversion Table for Weight and Mass Measurements

g	x 2.205×10^{-3} → ← x 453.59	pounds
g	x 15.4323 → ← x 0.064799	grains
g	x 0.03527 → ← x 28.3495	ounces
mg	x 2.205×10^{-6} → ← x 453 592.3	pounds
mg	x 0.01543 → ← x 64.799	grains
kg	x 2.2046 → ← x 0.4536	pounds

Table 4: Conversion Table for Pressure

Pa	x 0.145×10^{-3} → ← x 6.895×10^{3}	pounds per square inch
kPa	x 0.145 → ← x 6.895	pounds per square inch
kPa	x 4.0145 → ← x 0.249	inches of water column
kPa	x 0.295 → ← x 3.386	inches of mercury col.
psi	x 2.31 → ← x 0.433	Feet of water depth
kPa	x 0.102 → ← x 9.8	Metres of water depth

Table 5: Conversion Table for Length

°C	(1.8x°C) + 32 → ← (°F-32) x 0.5556	°F

Table 6: Conversion Table for Measurements

J	x 0.7376 → ← x 1.356	foot pounds
kJ	x 0.9478 → ← x 1.055	BTU
kW	x 1.341 → ← x 0.7457	hp (electric)

pH

A pH scale is used to measure the acidity of a substance. A pH lower than 7 indicates an acidic substance (maximum acidity = 0), and pH greater than 7 indicates a less acidic – or more alkaline – substance (maximum alkalinity = 14). A pH of 7 is neutral. Pure water has a pH of 7[1].

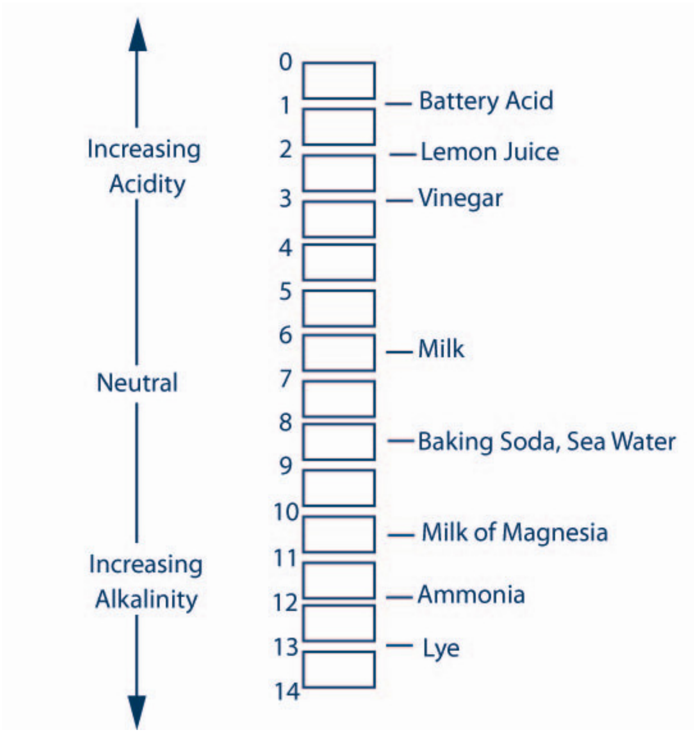

FIGURE 6: PH SCALE

[1] Environment Canada. 2005. Acid Rain and the Facts.Available at URL: http://www.ec.gc.ca/acidrain/acidfact.html

Mathematical Symbols Found in this Manual

Symbol	Name	Description
>	Greater-than	Used to express a larger value than a given value. For example: in the expression ($x > y$) ; x has a greater value than y.
≥	Greater than or equal to	Used to express a value that can be either a larger value or the same value as a given value. For example: in the expression ($x \geq y$) ; x has a either a greater value than y or it has the same value as y.
<	Less-than	Used to express a lesser value than given value.
≤	Less-than or equal to	Used to express a value that can be either a lesser value or the same value as a given value.
π	Pi	Approximately equal to 3.14; pi is a mathematical constant representing the ratio of a circle's circumference to its diameter.

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